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MARCH 10, 1981

# Social Sciences

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MARCH 10, 1981

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# Solar Physics, Astrophysics, and Astronomy

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frequency system and the trumform between the

proposed system and the trumform security. In

addition, we avaluate the degrae of langitude smearing which could result over the long term from the ourging of data sels organised in this system. Finally, no evidence of control of the radio equation by any of Satura's estailites is found. ISstura's rotallon period). Geophys, Res. Latt., Paper BOLLD&G

**AOFAME 62** 

7780 General or miscellaneous
A FIREBALL IN JUPITER'S ATMOSPHERE
A. F. Cook Harvard-Smithsonius Center for Astrophysics, 90 Carden St., Cambridge, Massachusette
02139 and T. C. Duxbury
Gno lirebalt was photographed during two encounters
with Jupiter. Its total huminosity was 1.2 × 105 o mag
sec (as standard range 100 km, II we employ the
luminous offisiecy proposed by Cook et al. 1080) for
slip flow of a maleoroid in its sen vapora we obtain as
salimated seed of If kg. A rough absolute magnitude
12.3 dering two exposures, we salimated a mushor
density near Jupiter of 7 > 10-25 gm<sup>-3</sup> for massac of
mateoroids of 3 kg and greater. This value is shout a
factor of oit, amilior than a rough upper limit reached
lrom an extraposition from terresirial observations of
mateora and comets. J. Gnophya. Sea., Graso, Paper 80C1832

# Tectonophysics

SILO CONVECTIOS CUPPANS 8 FOSSIBLE MANTE INSTABILITY DUE TO SUPER-TASSIC DEFORMTION ASSOCIATES WITH PHASE TRANSITIONS.

TRANSITIONS

T. H. Patrechtlar, Department of Geological Sciences, Stom University, Providence, ET 02912

Laborarary deformation aredian of metals and seco outday indicate that these solids are reserved as the stomagness of the second secon Gaoghya. Res. Lett., Paper |L0124

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CESENVETIONS OF FLEXURE AND THE RHEOLOGY OF THE

CELANIC LITHOSTREEM.

J. W. Bodise ilanont-Dohnety Gaological Obsetvatory of Columbia Marraity, Pallandae, N.Y.)

M. S. Stankjer and S. O. Vetts

Observations of flature indisate the sfessive
flatural rigidity of ocasote fithosphere is a |
tunction of the age of the lithosphere, and heart

temperature, at the rice of loading. We have
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that from experiments rich merbanics to wheter
else how the ilented personsers and rocal contrained by
also how the ilented personsers and rocal contrained
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oceanic lated loads in the loterior of plats suggest that failowing loading, rapid sires raiosasion oceans as the plote "thine" from he short-rown to its long-term (\*10" years) submired thickness. The mochanical thickness, which determines the afterive linear rigidity of the plats. In atrongly dependents on tespecture and weekly dependent on load olds and duration 191-10 m.y.). The results of our model for convergeer plats boundaries ouggest that days in the chape of the Outer Rise slong an individual fronch system may be due to variations to the horisontal load arring oreons the beneder | d bbari. The model pradicts a serve tone of big strain occumulation convented af a trent which in agroumant with variations in crustal valentias and salenticity pettarns observed closs seek trench systems. (Flexure, rhadeyy, stress trianslos, isoceany, oaheldante).

J. Gaophyo. Rus., Red. Poper 180025

# Volcanology

8699 Volconology topics
VD.CANICS AND STRUCTURE OF THE FAMOUS-AMMENDATE
RIFT: EVICENCE FOR CYCLIC EVOLUTION: ANAR I
K. Crons (Noods Hole Oceanographic Initiation,
Heads Hole, NA 02543, now at Lamoni-Debetty
Goological Observatory, Palisades, NY 10964) and
R.O. Boiland
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R.O. Bollord
A neor-bollow photographic survey on the MidAtionic Ridge From the FAMOUS region south to
Translation of unicapping to At lendic Ridge from the fANOUS region south is franslorm 8 ravoals structural and volcandisk widence for on othernating aldening and surviving rill valley. Extension wedges appear to be voting alling south from from from A and sorth from from 8. These merge at MI. Hers where the rill valley is morrowett and should like roughley giving the valley o symmetrical bourgles sheet for the valley of symmetrical bourgles sheet walls. Faulting on the strike of the intermediate, 100 obliques to the strike of the intermediate. Faulting and fissuring are antisymmetrical across the rift salley in contrast to the saler axisms into the strike of the saler axisms into the saler axisms in the s

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# **Editorial**

# Why Should I Invest in AGU?

This question is addressed to three age groups within the AGU memberehip-the young, the middle sge, end the 'you're looking line' group. For you, the reeder, we give the

As a junior member of the society I note the excliement of the meetings, the intensity of the discussion-especially In the labblee, over coffee or with beer; and the high quelity ot papers in the journela. I know of no better place to exchange ideas with othere from all parts of the country or even the world. AGU is a scientific forum with geophysical dimensions. I applied for membership because I wanted to be a part of it, end I em looking forward to e full career in geophysics. I can see the pleasure and satietection my seniors are deriving from their cereere. The AGU seems to be a common bond for them. Why should I invest in AGU? I am planning for the future, and I expect AGU to be en Important part of my life.

I have been a member of AGU for a little over 20 years. My enthusteam for geophysica ceme from IGY, Venguard, Minitrack, Mohole, World Wide Seismic Nets, end such. It sssms e long time ago. With the ecope of scientific knowledge doubling every 10 yeers, I would heve been isit fer bahind, essentially loat, without AGU to help keep me informed through its journels and meetings-e key factor in my conlinuing education. I have been an educator, but now I em on the 'receiving' end in scholestic matters. As e mensger, my primery concerns seem to be people end services, but the geophysical sciences and their applications to the solution of societel needs are the fundementals we strive to convert to profit. I look torwerd to enother 10 yeers with enother 'doubling.' So why should t invest in AGU? It is the same ea 'plowing profits back into the firm.' The dividends I return to AGU help to ensure that in 1991 the AGU will continue to be 'educeting' me. The finencial record of AGU over the past 60 years is excellent. My support at this time la one of the beat investments I can make.

Membership and perticipation in the affairs of AGU heve basin e major pert of my life in the profession I've followed for the last 40-plus yeers. I've found pleesure in my work and have enjoyed the essociation with my colleagues, and even though in these later years I cannot ettend as many of the mestinga, I look forward to receiving the abstrects and reports of the advences in geophysics. I heve been blessed to heve lived in the 20th century. There have been ups and downs, but being in geophysics, the ups prevailed. Now t look et money merket returne, conservetive investments, and discounte for senior citizens. So why should I Invest in AGU? To ensure that this generation and the ones lo follow will have the same, or even greater, benefits. Contributing to en endowment sufficient to ensure an adequate reserve and supporting worthy progrems in geophysics exemplifies unselfish cooperation, and to me, with my limited needs, these represent very sound 'Investments.'

> Cheriee A. Whitten Eerl G. Droeseler Co-Cheirmen GIFT Steering Committee



# TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

The Weekly Newspaper of Geophysics

Editor: A. F. Splifteue, Jr.

Send double-epeced menuecripte (tour copies) to Eos, AGU, 2000 Florida Avenue, N.W., Washington, D.C. 20009, or send them directty to one of the essociete editors with a copy to the ebove addrese. Advertising that meets AGU etenderde le accepted. Contsci Elleen Eos, Transections, American Geophysical Union (ISSN 0096-3941)

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Views expressed in this publication ere those of the authors only and do not reflect officiel positione of the American Gaophysical Union unless expressly stelled.

Cover. Tectonic setting of the Calebee Basin. All presently ec tive plate boundaries are depicted by continuous lines and former plate boundaries are depicted by continuous into boundaries are denoted by the sewtooth these with sawteeth on the overriding plate. plate. Spreeding centers are marked by solid lines with outward-pointing bold arrows. Strike-slip zones ere solid lines, with sense of motion defined by the arrows. The diagonety hetched region illustrates the broad region of current plate interactions, it is cheracterized by companying the company of current plate interactions. ized by compressional tectonics and zones blienear (generally, left lateral). [likestration taken from paper by J. Welseel, Evidence for Eccene oceanic crust, in The Tectonic and Geologic Evolution of Southeast Annual In The Tectonic and Geologic Evolution of Southeast Aeisn Seas and Islands, Geophysical Monograph 23, edited by D. E. Heyes, published by American Geophysical Union: 800 page 112.]

# Radioisotope Detection and Dating with **Accelerators**

A. E. Litherland and J. C. Rucklidge

University of Toronto

Recent developmente in maes spectrometry heve made possible the direct detection of meny neturally occurring long lived redicisotopes. Redicaclive eloms are present el such low concentratione that the sensitivity of the mass spectrometry hae to be increesed to detect parts per quadrillion (1015) in a sample. This eensitivity has been achieved, and some of the results taken at Rochester by the Rochester (University), Toronto (University), General Ionex (Corporation) collaboration are listed in the table. All the redtoactive isotopes lieted in the table are of importance in geochronology, end for <sup>14</sup>C and <sup>36</sup>Cl, sensitivilles better then perts per quadrillon (1015) heve elready been reeched. Eerly work on the ateble isotopes of plelinum has elready reeched below parts per billion (10°).

#### Mese Spectrometry of Rare Isotopas

	elt-Lite, Ion yeers	Sanellivily Reached	
 10Be	1,6	7 ppq	
1ªC	0.00057	0.3 ppg	
28AI	0.72	t0 ppq	
35CI	0.31	0.2 ppq	
120	16.0	300 ppq	
PL	steble	10 ppt	

ppb, perts per billion (10"); ppl, perts per trillion (10"); ppg, perts

These advances in mass spectrometry lechniques, which represent a new frontier in geochronology and in secondary ion mess spectrometry (SIMS) of minerals, are besed on the following principles:

1. The rare radioactive eloms in a sample are counted insteed of the perticles emitted during their radioactive

2. High mass spectrometer resolution, and hence low mass enectrometer efficiency, is avoided by destroying completely the interfering molecules.

Interfering etoms with nearly the same mass (isobars) ere elimineted if possible, and il necessary, by e number of lechniques.

The advantages of lon counting can be Illustrated by the defection of <sup>14</sup>C in the biosphere. The cosmic-ray-produced <sup>14</sup>C in contemporary biological carbon emits 15 beta rays per minute per grem. This beta ray counting rele, together with the known 5730-year helt lile of 14C, requires the presence of

 $8.5 \times 10^{10.14} \mathrm{C}$  etoms per grem of cerbon or about 1 pert of <sup>34</sup>C per trition (10<sup>12</sup>) of <sup>12</sup>C. Cleerly counting etoms is e potentially more sensitive technique then weiting petiently for the bets rave from radioective decay.

The counting of the 14C etoms or ions by maes epectrometry is made difficult by the presence of large numbers of molecules such as 12CH2 and 13CH, which have nearly the same mess es 14C. These molecules are readily destroyed etter ecceleration to e suitable velocity or energy. The high-veloc-Ity molecules ere readily dissocieted in collisions with gas elome such es ergon. For the dissocietion to be complete it is necessery to use a velocity euch thet et least three electrons ere removed from the molecule. This requires, in the ceee of carbon, an lon energy of 2.6 MeV, which is about 100 times as greel as used in the conventionel mass spectrometry. At 2.8 MeV, 50% of the etoma become C9+, and no molecules are left to interfere with the 14C+8 lone.

The Interfering 14N+3 lons are most easily eliminated by ueing negetive ions et the outsel, as the N- ion is unstebte, whereas the C- Ion is quite aleble. This eimple solution evoide the necessity of very high resolution meee spectrometry or the use of more complicated and difficult schemes tor distinguishing between the 14N and 14C etoms. In addition the use of negetive lons simplifies the destruction of the molecules because e landem accelerator can be used. In this type of eccelerator the negative ions are attracted toward a positive electrode in which the electrons ere removed to make positive ions, end the molecules ere dissocieted. The positive ions ere then eccelerated to ground potential. In this wey the negetive end positive ion mass epectrometere end ion eources can ell be conveniently near ground potential.

The final etom counting is usually done with detectors thef measure the ion energy, velocity, end rete of energy lose. The rete of energy lose measurement can also discriminele between light ions, such se 14N and 14C, and even 38Cl and 38S, end so edd confidence in the idenlification of the atome

The apperetus used for ultresensitive mass spectrometry el Rochester University is shown echematically in Figure 1. If le normally ueed se an accelerator eyelem for nuclear physics etudies, and it has been modified for mass epectrometric measurements. The negelive lone ere generated by cesium sputtering from colid samples, and in the case of <sup>14</sup>C detection, mass 14 lons ere selected by a mass epactrometer prior to injection into the 27-m-long molecular disintegrator. Ion current can be measured by a removable Fsredey cup (FC 1) prior to injection. The negetive lone are eccelerated to 8 MeV, in this case, and ere converted to C+4 ions, which is just as . effective in eliminating molecules as the conversion to C13 lone at lower energies. A second mass speciformetric eystern for the positive ione is uesd to eliminete the molecular fragmente. This ie followed by devices to measure the time of flight of the lone, their energy, their rate of energy loss, II possible, and finelly to count the lons.

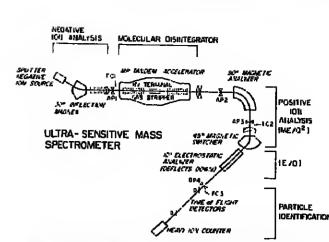


Fig. 1. The ion beam trensport system of the landem-accelerator-besed ultrasensitive mees spectrometer at the University of Rochester le ehown schematically, ion-beem-defining apertures ere deelgneled AP, and Faraday cups for ion current measurements ere deelgnated FC.

The pulse epectrum from the Ion detector is shown in Figure 2 for two semples of carbon. The top spectrum is from a cerbon sample provided by the U.S. Geological Survey from wood buried by en eruption of Mt. Shaste, in Celliornie, 4600 years ego, end the boltom spectrum is from grephite prepared from very old carbon. The change in the 14C counts is quile evident. The 14C concentration in the graphite semple is less than about 0.3 ppg. The 13C end 12C ton counta ero due to molecular fragments, end they can be eliminated completely il an electrostotic analyzer is used olso.

The procedure for eveluating isotope ratios is to measure the ton currents of the 12C14 and 13C14 in FC 2 or 12C14 ion current in FC 1 end the <sup>14</sup>C <sup>14</sup> counting rate in the heavy ion detector. One microampere of singly cherged ions is equivelent to 6.25 • 1012 ions per second.

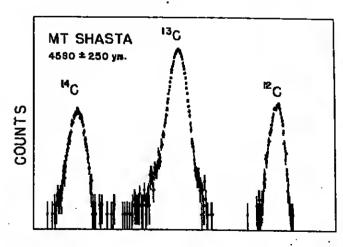
The results from the measurements on some carbon samples of known age are shown in Figure 3. Those samples were provided by M. Rubtn of the U.S. Geological Survey, and the logarithm of the meesurod counts of <sup>14</sup>C per minute per microampere of 12C - current is plotted against the known age of the samples. As expected, the measurements lie on a straight line because of the exponential radioactive decay law. It is worth noting that the <sup>14</sup>C concentration at 40,000 years is about 1 part 14C per quadrillion of 12C or 1 part in

The carbon samples used to obtain the data shown in Figure 3 weighed about s mittigram, and so to: the 40,000-yearold sample one would expect one beta ray to be emitted per month. This dramatically illustrates the increase in sensitivity resulting from atom counting.

The meximum sensitivities echieved at Rochester tor other tong-lived radioactivities ere shown in the table. Elsewhere, work on several of these radioisotopes has been extensive end will now be eummerized.

 ¹ºBe hes been extensively studied by G. Reisbeck et al. (Laboratoire René Bernas, Orsay, France) in samplee of geophysical interest, such ealice from Antarctice, ocean water, reinwater, deep oceen sediment, and to menganese modutes, by K. K. Turekian et el. (Yete University). The work by Raisbeck et al. was cerded out by using positive lons and e cyclotron, with discrimination between 10Be and 10B being echleved by renge eeparation. 10Be ia particularly easy to observe, end it is expected that negative ions and smell inexpensive landem ecceleratore about 2 m long will be quite sufficient for detection end meesurement.

 Extensive work on <sup>14</sup>C is taking ptece el meny laboretories, and three specialized mechanes, to be deacribed leter,



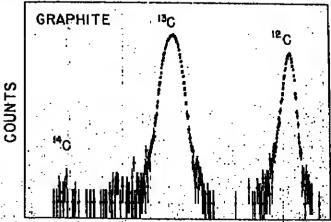


Fig. 2. The pulse spectra from the heavy ion detector shown i tigure 1 is displayed for a carbon semple from an eruption of Mt. Shaste and from grephite.

EFINAL

Fig. 3. The logarithm of the 14C counting rate divided by the 2°C ion current at the ton source is compered with the known age of the milligram geological samples.

ore under construction to extend the work. At present the occuracy of the isotopie ratio mnosurontents is being pushed toward 1%, which is quito sullable for dating of small orchoa-

- 3. 28Al has been delected at several loboratories. It is worth noting that the separation of <sup>26</sup>Mg is inclinated by the instability of Mg and the stebility of Al . The dating of ocean sedimonts and ico cores by measuring the retto ot <sup>26</sup>Al to 26Ba, which would be independent of cosmic ray intansity thiclustions, is now a roal possibility.
- Clin groundwater and metooritic samples has been oxionsivoly studied at Rochestor. In this caso it is, at present, nocessary to purity the samples carefully to remove sulphur bocause of the presence of <sup>18</sup>S, which else forms negative lons roadily. Forlunntoly, 36Ar doos not form stobta negetive
- 5. 129 has been datected at Rochester by mass spactrometry at levels down to 300 ppq. and it is expected that tag lovels as low as 1 ppg will prasent no problem in the futura. is generated in metaorites by cosmicrays and in the earth's crust by the spontaneous tission on 208U. The ratio 133,238U nt equilibrium is noar 10-11, which should be aesily observable.
- 6 Recantly, stable isolopes of platinum have been obsarved at balow the parts per billion level, and in principle it should be possible to increase the sansitivity further. This establishes the viability of studying heavy masses with lon mi-

croprobee such es osmium end rhenium isotopes for dating

The nuclear physics equipment at Rochester, which is ueed for uitresensitive maes spectrometry, is unnecessarily large for many such epplications. As mentioned earlier, ion anergles of ebout 3 MeV are required to ensure adequate alficiency for generating etoms with three electrons misaing. Molecules with three electrons missing fragment very repidly. As e result of the measurements at Rochester and Oxford universites, some reletively small tandem accelerators and their associated mass apactromaters have been designed eo es to be epplicable to a wide veriety of ultraseneitive meaeuremente

The complete ultresanelfive mass spectrome fers being built by General Ionex for the University of Arizone, Oxford University, and the University of Toronto occupy e space of 6 × 14 m, end e pien view of the device le shown in Figure 4. The system consists of a negetive ion mass spectrometer on the left, e 6-m-long molaculer disintegrator, an electrostatic anelyzer to remove molecular fragments, end a poelitive ion mass spectrometer with e detactor for ion identification and ion counting. The first of these systems will be ready for testing econ.

The eyatem to be installed at the University of Toronto should be in operation in May 1981, and it will be used for a variety of applicatione.

- Archaeological and anthropological <sup>14</sup>C dating of email e emplea up to eboul 60,000 years will be possible with accuracles better then 1%, or 80 years for younger specimens. 2. Tha 29Al/10Be detling of sediments end ice cores over
- the past 5 million yeers le being developed. 3. 38Ci end 129 dating of groundwater will be of use in
- hydrogeologicel studies 4. The elimination of molecules abould make SIMS etudies of minerals easier, end studies with micron eize beems will undoubtedly be velueble.
- In conclusion, tha future of this new frontier of geophysics and physics promises to be quite exciting.

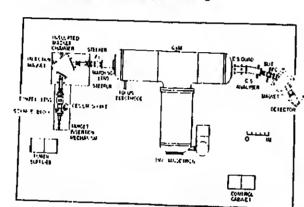


Fig. 4. A plan of one varsion of the ultresensitiva mass specfrometer being built in verious leboratoriaa. Feradey cups ara designated FC, end the electroetetic enalyzar at the exit of the 3MV landatron or molecular dieintegretor le tebaled ES. Tha genereting voltmaler for the measurement of the high voltege is designeted

Acknowledgments

The authors ara indebted to K. H. Purser, H. E. Gove. D. W. Strangwey, and other colleegues for meny confrigutions to thie frontier aree of study.



A. E. Litherland, F.R.S., is a nuclear physicial who received his doctorale from the University of Liverpool, after which he moved in Canade to work with Atomic Energy of Ceneda, Ltd., in Chelk River Thera, he maesured the epine of nuclaer states by observing the enguler correlation of particles amerging from nuclear reactions, in 1966 he moved to the Department of Physics, University of Toronio, where hale now university protessor. Prior to his involvement in the accelarator-mass epectromater work, he has concerned himself with low-anergy radiative capture in nuclear reactions, alectroliesional light alements, and the development of demage track particle delec-



J. C. Rucklidge is a mineralogist who took his B.A. tromCanbridga University and his Ph.D. from Menchester University Alexa spell in cloud physics et the University of Chicago, identifying he mineral particles which form the nuclei of naturalice crystals, held gen to use electron microprobe enalytical methods in geological problems at Oxford University. In 1965 he continued to developing strumentation and apply microenelytical techniques to natural male riele at the Department of Geology, University of Toronto, where he te now professor. His research has included work on pletinum miner alizetion end dafalle of the alteration processes in ultramatic rocks.

# 40° N. LATITUCE COMET IN EVENING SKY MORNING SKY AFR 15 |4.6 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 SOUTH WEST AZIMUTH, DEGREES

Fig. 2. Cornet Helley observing conditions in 1986 for observers located at 40°N letitude. Cornet positions are given for beginning of meming setronomical twilight or and of evening setronomical twilight. Approximate total visual magnitudes are given in parentheses idlowing detaa. Viewing with binoculare end ideel observing conditions are essumed.

in the Southern Hemisphere. The following description of observing conditions for comet Halley in 1985-86 is provided in The Comat Helley Handbook:

ft is assumed that the comet will be viaible to an observer if the comet ia ebove, and the eun is elmultaneously more than 1B° below, the local horizon. This condition assures that the evening astronomical twilight has ended and morning astronomical twilight has not yet begun (i.e., the comet is seen in e derk sky). The time interval for which this condition holds is referred to es the numbar of evallable dark hours. Figure 1 is e plot of the available dark hours vs. calender date for an observer at 35° north and 35° south latitude. Also plotted in the figure is the total appearent magnitude  $M_1$ vs. csiendar date. Figure 2 is e schemetic representetion es le how comet Halley may appeer on various

detes for observere located at the latitude of 40° north. The comet'e elevation ebove the local horizon and its azimuth (degrees eest of north) are given for the varlous detes. For each date, the comet's position is given tor the end of astronomical twilight, if the comet is in the evening eky, or the beginning of estronomical twilight if the comet is in the morning sky. These positions correspond to times approximately 70-90 minutes eller sunset or 70-90 minutes before sunrise. Very rough indications of the comet's tall length and orientation are given for e few representativa dates, elong with tha comet's epparent total megnituda  $M_1$  in perenthesis.

Because the comet occurs once every 76 yeers, nearly everyone in recorded history has had the opportunity to view it. If mey be wise to stert plenning for this once-in-a-lifetime experience.

#### Shuttle Project for Students

Selection of 200 semifinalists hee begun tor the first nefloral Space Shuttle Student Involvement Project, a joint effort of NASA and the National Science Teechers Associallon. The eemi finellats are being selected from 1500 en-

Objective of the project is to etimulate study of science and technology in grades 9 through 12. Students compete lo dsvelop payload axperiments suitable for tlight aboard the shuttle. The 1500 antries, grouped into 10 geographic Sress, are being reviewed by interdisciplinary teams of isachers, eclentieta, and engineers. Twenty students from each ragion will be eelected. Ten finalists will then be chosen on their scientific or engineering medi. The 10 netional winners and their teechers will attend a epecial aducation conference lete this aummer et the Kennedy Spece Center

A second conteet will open in September, with selection of winners scheduled for May 1982. S

# A-21 Compilance

A-21 is the number designation given to en OMB (Office of Menagement and Budget) directive on coaf accounting to universities and other institutions that receive lederal research grante. This circular leys down rules for grents. It requires the accounting of a university reasercher's work to be made in terma of actuel time apent, or in terma of e

reguely defined percent of effort. Most university profeeeore realize that eccountability is actually messured by a group of their peers—the group that eventually decides whether or not to recommend approval and funding for the next proposel or extension. Thus langible resulte eeteblish that a scientiet hae done hia prolosed job-not his houre (or '% effort'). The OMB eccounlants went the booke to be kept in hours but will accept percent of effort reports.

The real problem arose whan OMB included a lactor called the 100% reporting requirement. This states that a 388 srcher must account for 100% of his professional time (or effort) in separate categories, including those portions not supported by a research grant. The confirmation of Banselese concepts, euch as percent of affort (would a prosssor have to account for hie thoughte?), and impossible rules (professore often teach, do research, administrate, etc., all at the same time—and after normal working houra) heve led to a sort of cynicel compliance by most researchers. With all due respect to careful cost secounting procedurss, for a university proleasor the rules are meaningleea and because the activity breakdowns often cannot be done as required, compliance becomes labrication. According to D. Allen Bromley of Yale University (Physics Todey, February 1981), 'University laculty are being lorced to give an-Swere that they know are completely meaningleed; in effect they are being asked to fabricate e result, and this simply goes against the grain of most people . . . The Federal Government does not own you 100% of your time just be-

Cause it may support some smell fraction of your research. This ie the first year for implementation of the rules specified in A-21. As the flow of paperwork in the form of clivity reports grows, so does the cynicism and protest. Within the National Academy of Sciences, University of Chicago mathematics professor Seunders MacLane has diculated memos and railled proteat. Now the Academy has resolved to disapprove of the accounting rules. It has,

been proposed that OMB table the new rules until the problems can be addrassed, and OMB, while not saying how liberal it will be in enforcing the rules, is taking staps to etudy the metter. Possibly other reporting methods can be davised, end evidently OMB is open to suggestions.

Most universities ere going elong with the A-21 rules, but the tecuity are none too pleased with the proceduras. In a few cases, OMB hae allowed postponement of compliance If elternativas can be suggested. Among the suggestions now being tasted are those that set statistical samples among the feculty, relieving the rest of the grant-supported protessors of the burden. This plan would appear to be en eeeement of the number of compliances only and not en eeeement of the rules tor those eampled, who must report 100% activity. Aside from the Netional Academy of Sciences, it eppears that Yale University has bean a cenier of anti-reporting agitefion' (Phyeics Today, v.e.), particularly by its precident, A. Serilett Glametti, and by mathemetics profeasor Serge Leng. Yale has been invited by OMB to suggest elternetivee in time/effort reporting. It eeems that e move towerd a kind of lock-fund concept, with reference to ealary-benefits-overheed mey be occurring. The plen to test the notion of e statistical aampie for cost accounting may be tried at Stenford and other universities over the next year. Further modification of the guidelines to get around the requirement of reporting of an investigator'a total activitles would result in a more acceptable system—a system thet university grants end contracts were designed for, ee opposed to the prolit-oriented contracts normally written for Industrial research.—PMB &

# NAS Forms Geological Sciences Board

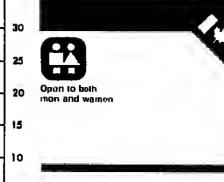
A new board to help guide geological research has been formed by the Neflonal Acedemy of Sciencea' Assembly of Mathematical and Physical Sciences. The 15-member Geological Sciences Board probably will hold its firal officiel meeting in April, according to board chairman William R. Dickinson of the University of Arizona

The board'a formation was apurred by the lack of syaternatic and continuous ettention given to geological sciencee in the past end by the increasing contributions geology makee lo society, explained Joseph W. Berg, Jr., executive secretary of NAS' Office of Earth Sciences. The board la expected to IIII a gap in NAS activities where disciplinea euch as hydrology, paleontology, and geological engineering have not been represented, Dickinson added. These

topics have been handled by ad hoc committees. What the Geophysica Research Board does for geophysics, the Geological Sciences Board will do for geology. The new board will review and coordinate geological research, help to asteblish scientific policy, and recommend topica for future research. The board will be an operating board, Berg said. That le, if will determine what geology problema demand attention and will pueh for action on those problems. However, the board can only recommend.

Topping the list of taaka to be fackled is the eefablishment of a geologic mapping and data base, Berg eald. This basic activity la not complete deeplie efforts by the U.S. Geological Survey, other boards, and ad hoc geology committees, he explained. Thei human beings construct buildinge talier then the depths at which we know geological detalls is incongruous, commented Berg.

Other projects with high priority include investigating problems of lend use, specifically the siting of dams and nucleer powerplenis; studying crustel structure and evolu-



#### MARINE GEOPHYSICIST

Salary: To \$38,686 Ref. No.: 81-NCRAO-EMR-3

Energy, Mines and Resources Cenade Gaolegicsi Survey of Casade Oertmouth, Neve Scotle

The Atlentic Geoscience Centre at the Geoford Institute hes evecancy for a scientist to conduct research progrems refered to geophysical studies of the earth and its tectonic processes, perticularly by the development and testing of theoratical models and, where such programs have specific application, to the prectical consequences of continental mornin development end its rosnurca potentiel. While some research programs may be totally independent. others must provide theoretical geophysical input to programs already unrierway at the Atlentic Goosciegoe Centre; these ore directed toward investigation of thus structure end origin of centinental margins off Eastern Canada and the Arctic, basin unalysis and hydrocarbon inventory of Eestern Caparla end quaternary marine geological processes. Experience as related to the alruvo is

#### Qualifications

Graduation with a Doctorate degree or a lesser riegree with research experience and productivity equivalent to a Doctorate degree, from a recognized university, in geophysics, geology, physics, mathematics or a related

Knowledge of English is essential

Clearance No : 110 322-013

Additional job information is available by writing to the address below

Toute information relative à de concours est dispenible en frenceis at peut être obtenue en écrivant à l'edresse

# How to spply

Send your application larm and/or résumé to: J. Girling Netlenal Cspitel Region Staffing Office Public Service Commission of Canada L'Esplansde Leurier, West Tower Ottswa, Ontario K1A 0M7 Closing date: April 30, 1981

Please quale the applicable reference number at all times.

# Canadä

tion; assessing mineral deposits; and suggesting the involvement of United Statae geologiets in International proj-

Rotation of board membare will tollow that of other NAS boerds. Members will be appointed to 3-yeer terma. Nominations for replecemente will be teken from academie, government, industry, end professional accieties.

Approximately \$125,000 will be required to finence the new board, Berg asid. Requeste for tunds have been made to various government agencies, including the National Science Foundation and USGS.—BTS ®

#### **Menard Steps Down**

Whan e new administration lakes over in Washington, if is not unusual at all for top government officiale to be replecad. The administration will be held responsible for the auccesa or failure of the federal egencies, so it is logical for a new president, or his close advisors, to approve top-level staff. The level defined as 'high' hee been extended, particularly aince the deys of the Nixon administration, to beyond cabinet and department secretery, reaching broadly to within the atructure of federal agencies. The U.S. Geological Survey remained unscethed by political appointmenta until 1977, when the Certer administration ebruptly removed Vincent McKelvey from his poeition as director. Now, the Reegan administration has followed cull by terminating the eppointment of H. William Menerd, U.S.G.S. director for the past 4 yeers under the Carter edminietration. in both inatancea, aubmittal of resignation letters was a courtesy-a formally, but ecceptance of their raeignations waa not. Both McKelvey and his euccessor, Menerd, are professionals, but both were treated politically. These are only the first and second cases of political interference at the U.S.G.S. in over a century. Until these instances, the position of director wae held as a purely proleagional one.

Beyond just e reshuffling of personnel at high levele of government, however, it le important to note that the U.S. Geological Survey's mission has changed markedly in re-

News

# Wetlands May Clean Geothermal Water

Development of geothermal reacurces may help to ease energy problams, but water quality problems could result from the disposal of spent geothermel brines. Research by EG&G Idaho shows that man-mada wellands may provide a mora economic disposal system than do conventional trealment and disposal methods.

Most geothermel water contains high concentrations of dissolved solids and trace elements, including fluoride and boron, which can be harmful to water quality end organisms. Because of these high concentrations, only a limited number of methods can be used to dispose of used geothermat water. These include Injection wells, eveporation ponds, and disposal Into surfece waterwaya.

The treatment proposed by EG&G deposits the spent brine in a smell artificial walland planted with sefected aquatic plants such as cettails and duckweed. These plents would remove the chemicals from the water, according to Bob Breckonnidge, tosk manager at the rosearch center at tho Rait River Geolharmal Experiment Site, near Melta. Idaho. Plants must be harvested regulerly, he explained, to provnni decay end the reintroduction of the chemicals into tho water. If the plants were burned os an energy source, the fluoridos would convert to hormless hydrogen fluoride and would be reteased into the etmosphere, EG&G eald. Fluoride and other chemical residues would be buried in

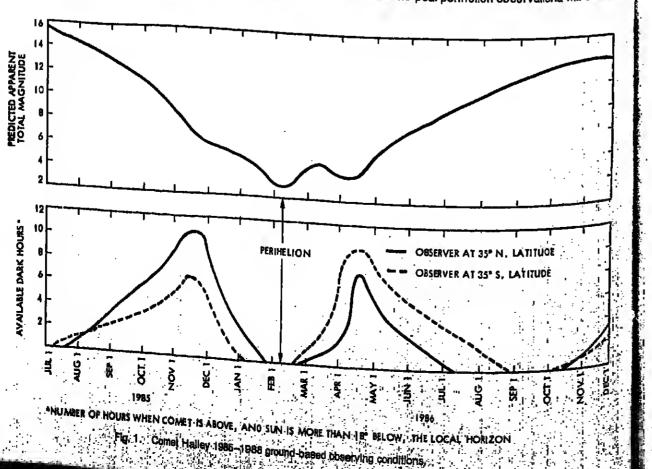
# As Comet Halley Approaches

The certical probable recorded appartition of the comet Halley wee 240 B.C., although what could be considered es deta gathering on the comet wea begun by Johannes Keplor in 1607. Kepler's observationel data consisted of vieual observation, which started on September 28 of that year and continued through the year, end then agein in 1682, 1759, 1835-36, and 1909-11, the last of which wea a precise telescopic observotion. As we approach the arrival again of comel Halley in 1985. Observers on the nationat scene are calculating the physicet behavior to be expected. (The Comet Halley Handbook: An Observer's Guide: Created for the International Halley Watch, D. K. Yeomans,

Jet Propuleion Laboretory, Pasadene, Calif., 1981). A continuing search for the comet's errival bagan in November 1977, but was unsuccessful. At thef time the magnitude of tha comet was actimated to be lainter than 26. When it arrivss in 19B5 it will be herd to ses by the naked eye and probably will only be observed by those who ere equipped with telescopee or binoculare end know where and when to obsarve. It will be necesseary to observe outside of popu-

ious areaa to avoid significant effecte of arilficial lighting. The pre-epace end post-perihelion close epproaches of the comet and Eerth will occur on November 27, 1985, and April 11, 1988, at minimum dietances of 0.82 and 0.42 AU 8aaed on observationa in yeers paat, the comet'a visual tall length appears to be longest eltar perihelion.

Because of the unfevoreble positions of the come with respect to the earth and the eun on a given dete, the comet'e observebility will depend on the observer's letituds. In genarel, belter observing conditione for the Northern Hemisphere will be aveilable for pre-perihelion positions of the comet, while the post-perihelion observations will be belief



(News cont on page 108

cent years. President Certer's secretary of the Interior, Cecii D. Andrus, was widely quoted to the effect that the Survey, and by association, McKelvey, was not cried toward the administration's views on domestic oil and ges reserves. By the aamo token, Reagan necused interior, including the Geological Survey, of being more concerned with conserving resources than with exploiting them' (Science, February 1981). The new secretary of the interior, James G. Watt, has ousted alt the directors and heads of the relevant egencies within the interior Department in eneffort to lum the situation eround, at lessit politically.

There eeems to be a set of clear mendates of the new saministration that will influence resource-sensitive federat egencies. Nonethetess, as reported in Science, it is widely known that the Geological Survoy has 'an outslanding record for sciontific excallence and professional integrity.' The replacement of personnel at the level of the office of director may continue to be only a part of what Science has termed 'wholesale house cleaning.'

Potential cendidates to replace Menard may wonder whether such a great personal commitment cen or about the made for such a politicelly sensitive position.—PMB &

# NASA Establishes Speakers Bureau

A Planetary Geology Speakers Bureeu hes been eatablished to present to universities and other institutions the latest results of eoler system exploration end to present colloquin on topics of current interest.

Filtoen lecturers troni ncross the United States comprise the speckers bureou, which was established by NASA's planetary geology program. Those speakers can locture on such topics as Venusian geology, planetery velcanism, lunar geology, the origin of esteroids, Martin geology, Venusian technics, comparative planetary geology, the Allende motocrite, comot exploration, the Galiloon satellites, and geologic evolution of the terrestrial planets.

The host group or department wilt be expected to pey the customary exponses essociated with the epeeker's travel. To schedute a speaker or for more information, contact the Planetary Goology Speakers Burgau, Department of Geology, Arizona Stoto University, Tompo, AZ 85281, or telephono (602) 965-7092.

#### Geophysicists

George S. Benton, tormer associate edministrator of NOAA, has returned to his professorship in the Department of Earth end Planetary Sciences at the Johns Hopkins University.

# Geophysical Events

The following item complises selected reprints from SEAN Bulletin. 6(1), January 30, 1981, a publication of the Smithsonian Inetitution

# Voicanic Activity

Mount St. Helens Volceno, Cascade Range, eouthern Washington, USA (46.20°N, 122.18°W). All times are local (GMT - 8 h). Leva extrusion resumed February 5, sdding s substential quantity of new material to the dome that grew in the crater efter the October 16-18 explosions and the two new lobes produced in late December end early January.

Minor activity—January: Atter growth of the Oscember January lobes ceesed between January 2 and 4, outward movement of the northern crater rampart gradually declined to en average of about 1/2 cm'day, ellhough rates were varieble and data were limited. January selemicity was the quietest of any pariod since earthquakes began Merch 20. Only 40 discrete events were large enough to be recorded on three or more stations of the U.S. Geologicel Survey-University of Washington aetsmic net at Mount St. Helens. in contrast to 136 in December and 74 in November. Of the January earthquakes, about 10 were low-trequency events associated with dome growth early in the month, many others were rock avalanche events, and a tew accompanied ojection of eleam plumes. A new tumarole opened Jenuary 9 on the eastern margin of the lave dome. This tumarole was the probable source of small stoam and on Jenuary 16 of 1152 (to 3 km altitude) and January 20 at 1204 (to al least 3 km), both accompanied by bursts of soismicity. Similni setsmic activity was recorded January 24-25, and beld perties saw light osh deposits on Iresh snow. Severat similar bursts occurred January 31-February 1, two of which could be correlated with stsam and ash emission. However, another steem plume was ajected without accomponying seismicity.

Incrensed deformation and seismicity: Detormntion and setsmic activity both began to increase at the beginning of February. Radial lissures in the craier toor begen to widen at a noticeably taster rate, and movement of thrust laults occolorated. A larger number of glowing cracks in the eurtace of the tava dome indicated that its iemperature was increasing. On Fobruary 2 at 0336, a 4-min buret of seismic-Ity was tollowed by a magnitude 2 certhquake at 0340, thon low-leval hormonic fremor wea recorded until 0630. Occasional bursts of setsmic activity continued through the day, and 35 minutes of low-level tremor was recorded that night. A gradual increase in discrete earthquakes began February 3. Occasional low-level fremor was recorded, as were sevaral burats of aaismicity, one of which was essocialed with a small plume at 1220. By midnight of the night of February 4-5, the number of discrete events had resched 4 to 5 per hour and continued at this rate for about 8 hours,

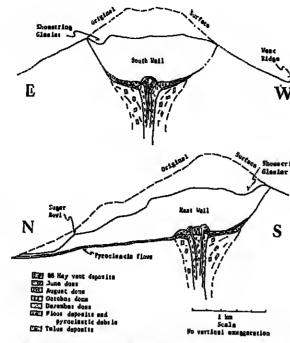


Fig I. East-west and north-south cross sections through Mount St. Halsns. (By Michael Doukae, U.S. Geological Survey, Jenuary 1981.)

Lave extrusion: Juet before 0500, the U.S. Geological Survey end the University of Washington Issued an edvisory predicting an eruption within the next 12 hours. Seismicity begen to decline about 0600, probably signaling the beginning of leva extrusion. By 0800, eerthquakes were occurring of a rate of only about 1 per hour. Very heavy steaming obscured the crater, but new leve could be seen on the October dome during shout 30 eeconds of vielblility. The number of discrete selemic evente discreased turther by mid-eltemoon, remaining et many tewer than 1 per hour through Februery 8. However, bursts of unusual eelemic signals were recorded, possibly caused by lava extrueion.

tmproved visibility reveeled that the new lava was extruded through the collapse pit in the center of the Oclober dome. The new melerial appeared to have both uplifted and overridden the October dome, leaving this area about 35 m higher by the time growth apparently stopped during the night of February 8-7. The small northwest lobe, which had been emplaced during the December-January activity, was pushed about 12 m to the north end partially overridden by new lave. New thrust teulling also occurred in the southwest part of the creter, but it was much less extensive then the thrusting associated with the December-Jenusry activity. The incresse in dome volume produced by the February extrusion was roughly equal to the volume of lava produced by each of the two previous events, but et press time it was not possible to determine how much volume wes of new leve on the surface and how much was caused by uplitt of preexisting lobes.

Information contacts: Don Swanson, Chris Newhall, and John Dvorek, U.S. Geologicsi Survey Field Office, 301 E. McLaughin, Vancouver, WA 98663.

Sieven Malone, Christina Boyko, Eillot Endo, and Creig Weever, Graduate Program in Geophysice, University of Washington, Seattle, WA 98195.

Robert Tilling, U.S. Geological Survey, Stop 908, National Center, Reeton, VA 22092.

Pilon de la Foumaise Volcano, Réunion island, Indien Ocean (21.23°S, 55.71°E). All limes are locel (GMT + 4 h). A summit area eruption of Piton de la Foumeles be-

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phose eruptive

CARTE SCHEMATIQUE DES ERUPTIONS DU VOLCAN DE LA FOURNAISE

Fig. 2 Map of the calculate of Pinn de le Frumaise (From Krefft, M., and A. Gerente: L'activite de Piton de la Fournaise entre Oscillatoria (M. 1973, C. R. Abad. Sci. Paris, Série D., 284) 807-610, 1977.)

gan on February 3 atter 12 days of local earthquakes and 17 cm of euromit intiation. After a fairly sudden caset of selsmicity January 23, about 40 magnitude 2 events were recorded delly by the newly established Volceno Observatory of Réunion. The day belora the siert of the sruption 73 eerthquakes were recorded, with foci about 1 km beneath Cretere Bory, the smaller of the two summil craters (eee Figure 2). Seismicity intensified in the hour prior to the tirst eruptive activity on February 3. About 250 email discrele evants were followed by 5 minutes of hermonic tremor, then at 2030 a small fissure opened in Cralère Bory, & minor isva flow wes extruded during 2 hours of eclivity along this fissure, and a 6-m-high hornito formed at the vent. During the eecond hour of the eruption, a email amount of sa Isva flowed from a vent shoul 200 m below the rim separating the targer Cratere Oolomleu from Boy, This lave covered about 1/4 of a small creter ruin (Enclos Velaln) between Bory and Dolomieu.

After about 2 hours, two or thrae small fiseures opened on the northeast side of Cratère Dolomleu, each extruding s lava flow about 100 m long. The next morning et about 0400, a 300-m-long north-eouth trending fissure formed lower on the northeast elde of Oolomleu. Three spatier vents were active initially, but within en hour, founteining (15–30 m high) was limited to the lower portion of the fissure. Leve flowed downslope through channele end lava tubes onto the caldera floor.

As of serily February 6, lavs tountaining as much as 70 m high wes continuing from a 30-m-long segment of the lower end of the fissure. The activity had built a smell, songated cone with thres vants. The tava flow, composed of aphyric besalt, was 1.5-2 km in length end covered several thousand square meters of the caldera floor. Seismicity beneath Cretère Bory had stopped a few hours after the sruption began, but small evants were occurring February 6 beneath Nez Coupé de Ste. Rose, on the caldera's northern rim.

Thia eruption produced mora lava then the two most recent previous aruptions, May 28–29 and July 13–14, 1979. However, the 1961 volume is of the same order of magnitude as hes bean extruded by Piton da la Fournalse in most of its numerous lava flow eruptions from the summit area in the past 50 years.

Information contacts: L. Stielijes, BRGM, Service Geologique Regional, B.P. 1206, 97484 Saini Denis, Réunion. Volcano Obeervatory of Réunion.

Maurica Krafft, Equipe Vulcain, B.P. 5, 68700 Cernsy, Frence.

Whita Island Volcano, Bay of Pienty, Naw Zealand (37.50°S, 177.23°E). New Zesland Geological Survey personnel flew routina surveillance over White faland (active since December 16, 1976) on the morning of January 8. In the 10 minutes they were over the Island the voluminous convoluting emissions of white steam and gas clouds obscured their-view-sround and into 1978-Crater. The 600-750-m-high eruption column was elightly ash charged in its lower portion. The main crater was thickly covered with eroded brown-green ash. Impact craters could be seen extending a lew hundred meters northeast from 1978 Creter. Conspicuous blue tumes were associated with the sleam-gas column rising in the 1914 landelide ares just southeast of 1978 Creter.

Selemicity eince the last ground inspections in early December was characterized by four distinct periods of marked increase. Intervals of high-frequency, high-emplitude tremor were recorded tor 32 hours on December 15-16, for 35 hours on December 22-23, and for 26 hours on December 27-28. Strong ash emissions were likely to have occurred during thase periods, Large discrete serthquakes were recorded on December 14 and January 2.

(4972-4973)

THOIL

fniormstlon contect: B. J. Scott, New Zealand Geological Survey, P.O. Box 499, Rotorua, N.Z.

Krafie Caldera, Mývetn Area, Icelend (65.71°N, 16.75°W). All times ere GMT. The following is e report trom Kerl Grönvold and Páll Einarsson.

Since the eruption from the Krefls fiseure swerm in October, Krafla hed intialed as betore. The previoue ground level was reached in late November. A emeil, elow defletion took place 25–28 December with magme movement toward the N, but no eruption occurred, infiation resumed, end the ground fevel et which previoue deflation events end eruptions were triggered was egain reached about 10 Jenuery, but infielion continued.

On 30 Jenuary at about 0700, slow deflation of the megme recervoirs started, es recorded by tiltimatere at the Krsfla power plant. The rate of deflation rapidly incrseed and about 0730 tremor appeared on esismometers. Deflation rate end tremor amplitude reached e maximum at about 0900 end daclined very gredually thersafter. The earthquake epicenters indicated movement of megme along the feult swarm toward the N. Soon efter 1400, e fissure eruption started in the fault ewsm 8-9 km N of the center of the magme reservoirs. The flesure soon extended to 2 km length end the Isva front quickly moved toward the N. The eruption site is close to those of July and October 1980. and the eruptive behavior to broadly similer. In the morning of 31 January, the tissure hed ehortened to about 330-400 m, and the lava production rete had decreased somewhat.

The eruption was continuing on 2 February end very slow deficition also continued.

The sruption site le in an uninhabited area and posee no danger to the local population. Observations are hampered due to remoteness and difficult weather conditions.

Informetion contacts: Kart Grönvold, Nordic Volcanological thetitute, University of fcsland, Reykjevik, Iceland, Páll Einarseon, Science Institute, University of Iceland, Reykjevik, Iceland.

Marion Island Volcano, Prince Edward Islands, Indien Oceen (46.90°S, 37.75°E). The following is from a report by Shsun Ruseetl and Aldo Berruti.

During the first week in November, research station personnel visiting the west side of Marion Island observed two new cinder cones, three smell lava tlows, and freeh tephre deposits, none of which were present when the scientists were last in the area in February.

Russell and Berruti traveled to the eruption site in lete November. Regrowth of burnt vegetation indicated that the activity had probably occurred at least 2 months earlier. The smeller of the two cinder cones, about 6 m high with a creter 15 m in dlameter, had tormed at the summit of Kaalkopple, an eroded, 100-m-high tuff cone. A tava flow that appeasntly originated from the west (seaward) flenk of the summit cone hed poured over neerby cliffs 50-70 m high and ponded in a small amphitheeterlike aree at their bese. About 10 m of lava remained in the amphitheater in Novsmber, but caves above this levet were partially filled with leve. Some ot the lava had drained from the amphitheater and continued about 100 m seaward, tlowing into the ocsan and torming e front about 120 m wide and 10 m high. A isva tube seen et the eouthern edge of this tlow in early November had collapsed by the time Russell and Berrull saw it on the 26th, forming a 4-m-wide trench. This tiow covered about 2 hectares, including the portion between the summit cone and the cliffs.

A second lava flow occupied a few hundrad square meters of the promontory above the amphitheater mentioned above. A small amount of this lava had spilled through a fissure onto the first flow, but most remained on the promontory or poured over its concave northern cliff face into the

On the flank of Kaalkopple, east of the new summit cone and near its base, a larger lephra cone had formed around a 35-m-diameter creter. The east side of the cona was breached by a lava flow, 35 m wide as it emerged from the creter, that eventually reached 50 m width before diverging into two lobes. One lobe flowed about 350 m to the northwest, this aecond about 200 m to the south along a shallow valley. The total erea covered by this flow was about 7 hectare.

Irregular blocks and apheroidal bombs nearly 1 m in diameter were found on the flank cone. Fusitorm and ribbon bombs fell as much as 350 m from the cone, with heaviest lephra fell extending from its eastern, breached, side. A continuous layer of ash and laplill covered an arss extending several hundred meters to the east and 40 m south of the two cones, with ecettered fragments found 250 m to the south and much farther to the eoutheast.

No other eruptions have been reported in historic time from Marion fsiand. Some unvegetated lava flows appear no more than a few hundred years old [Verwoerd, 1987].

#### Rsferences

Varwoerd, W. J., Marion and Prince Edward Islanda, Neture, 213, 5073, 230–232, 1987. information contacts: Aldo 8 erruti, Percy Fitzpetrick institute, University of the Contact of the Co

versity of Cape Town, Rondabosch 7700, South Airloa.
Shaun Russall, institute of Environmental Sciences, University of Oranga Free State, Bloemfontein 9300, South Airloa.

M. D. du Pleasie, Gaological Survey, Privete 8ag X112, Pretorie 0001, South Airloa.

C. G. Hide, Office of the Solentific Counsellor, South Airlean Embassy, Suite 300, 2555 M St. NW, Washington; DC 20037.

Paluweh Voiceno, Lesser Sunda latends, Indonesia (8.32°S, 121.71°E). All times ere local (GMT + 8 h). Activity at Peluweh began to Increase on November 5 and continued intermittently through the end of Jenuary. On No-

vember 9, an eruption column rose 1 km trom the summit crater. Bombs tell nearby end 2 mm of esh were depoeited 1 km to the west. Bombe end esh were ejected for about 15 minutes, sterling el 1115 on November 13, Irom e aummit crater vent 40 m in diemeter. The tephra column reached 700 m in height. On January 27, ejecte set buehee at ire near a tienk village. Delonations trom explosions on January 31 were heard et Kota Baru, Floree Islend (50–60 km from the voiceno) et 0740, 0803, 0807, 0913, 1030, end 1215. No additional activity hed occurred as of February 5.

Informetion contacte: Adjat Sudradjet, Director, and Liek Pardyento, Senior Voicanologist, Voicenological Survey of Indonesia, Diponegoro 57, Bandung, Indonesia.

Ksrkar Volcano, off the north coast of New Guines (4.65°S, 145.96°E). The tollowing is a report from the acting senior volcanologist.

A trenelent increase in hydrothermal end fumeroild activity for 2 to 3 days at the beginning of December coincided with the onset of seasonal heavy rains. Minor geysers were observed on the floor of 1979 Crater. There were voluminous emissions of white vepour from a landside on the Baglel side of 1979 Crater tioor. Fumarolic activity was strong on the Walde of Baglel Cone and on the Eatle of the caldere floor right up to the celders well. Weak to moderate vapour emissions at these localities continued for the rest of the month.

Karker began en exploeive eruption in Jenusry 1979.
Two volcanologists were killed in March by an explosion from the southeast toot of Baglai Cone.

Informetion contact: Acting Senior Voicenologist, Rebaul Observetory, P.O. Box 388, Rebaul, Papue New Guinea.

Lenglie Volceno, New Britein Islend, Pepua New Guinea (5.53°S, 148.42°E). The following is e report from the acting senior volcanologist.

Vapour emissions continued from Creters 2 and 3. Some email ejections of brown-grey ssh rose from Creter 2. The lave flow from Creter 3 was still active and had almost reached the terminus of the 1975 flow.

Langlia hes been active since 1973.
Information contect: Acting Senior Volcanologist, Rabaul
Observatory, P.D. 8ox 386, Rabeul, Pepue New Guinee.

Menem Volceno, off the north coest of New Guinea (4.10°S, 145.06°). The tollowing is e report from the acting senior volcanologist.

Moderate to etrong light brown to grey esh-laden vapour and, rarely, dark brown dust were sporadically
ejected from the S vent. The main vent occasionally
emitted weak white vepour. Light eshtall from the S
vent was recorded at neerby Tabele on 2 December.
Low rumbling noises were heard on 20 and 25 December. A weak glow was observed et night from the S
vent from 26 to 29 December. Seismic activity was at
its normal level. Redial tilt remained telrly steady after
Initiation of about 10 microradians during September
and October. Tangential tilt commenced a downward
frend showing e tell in level to the E of about 8 microreclines.

Manam'e current eruption begen in 1974. intormetion contact: Acting Senior Volcenologist, Rabaul Observatory, P.O. Box 386, Rebaul, Pepue New Guinea.

Ulawun Volceno, New Britein Island, Papue New Guinea (5.04°S, 151.34°E). The tollowing is e report from the ecting senior volcanologist.

with only continuous moderate emission of white vapour from the summit creter. Ulawun had s brief, intense, explosive eruption on Oc-

The volcano was very quiet throughout December

tober 8-7, 1980.
Information contect: Acting Senior Volcanologist, Rabaul Observatory, P.O. Box 388, Rabaul, Pepua New Guinea.

Sakurazima Voiceno, Kyushu, Japen (31.58°N, 130.65°E). Ali ilmes are local (GMT + 9 h). A buret of B-type earthquakes, which began at 0200 on January 18 prompted the Japan Meteorological Agency (JMA) observatory et Sakurazima to Issue an explosion warning et 0930. Reflected glow was seen over the summit thet night. Four strong axplosions occurred during the next 2 days. Each of the first three produced a 200 m-high incandescent column. The tourth strongest explosion et 1632 on January 20 ejected an incandescent block their formed a 1.3-m-diameter cratar when it fell near an inhabited sres. Similar occurrences of B-type earthquake burats, reflected glow of the lava mound in the creter, and explosions were observed in July and August 1979.

None of the January explosions caused any damage. Information contact: Selemological Division, Jepan Meteorological Agency, 1-3-4 Otemachi, Chiyoda-ku, Tokyo 100, Jepan.

TABLE 1. Explosions et Sakurazima, Jenuary 1981

Dale t Number 1	2 1	6· 1	. · 8	8 1	9 · 1	10 1	14 1	
Dele 17	t9	· 20	21	<b>25</b>	28	29	31	Total
Number 1	2	· 2	1	1	1	1	1	18

Tarumai Volcano, Hokkeldo, Japan (42,68°N, 141,38°E). Selsmio activity at Tarumai increased again to more than 400 recorded events during Januery. No eruption has yet been observed, About 200 events per month

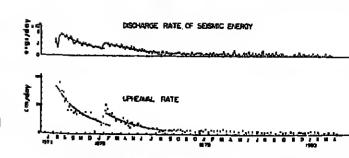


Fig. 3. Discharge rate of selsmic energy (ergs/dey) from Usu, August 1977—April 1980 (top) and uplift rete (cm/dey) of the 'New Mountain' cryptodome (bottom) for the seme period. Note the increase in February 1978. [Dale ere from I. Yokoyeme.]

were recorded in November and December, etter over a year of lewer than 50 events per month. The lest eruptions occurred in December 1978–Mey 1979.

Intermetion contact: Seismological Divielon, Japan Meteorologicsi Agency, 1-3-4, Otemechi, Chiyoda ku, Tokyo 100, Jepen.

Uau Voicano, Hokkaido, Jepan (42.53°N, 140.83°E). Cryptodome uplitt and local selsmicity continued through 1980 at Ueu, elte of e major explosive eruption in August 1977. Weeker explosive ectivity hed occurred through October 1978. Since then, gredually weekening sleem emission from the vents formed in 1978 has been observed.

Local eeismicity conlinued en Irregular decline through 1980 (see Figure 3 end Table 2). Felt shocks averaged 3 per day in 1980, but swarms of 30—40 left events in a single dey occurred obout once a month. The earthquakes were caused by subsurfeco magma movement associated with cryptodome upilit. Careful correlation of seismic rocords with observed surface deformation end faulting revealed that targer eerthquakes occurred simultaneously with meesurable tault movements.

TABLE 2. Number of Local Earthquekes per Month, Usu Volceno. Januery-Decomber 1980

Month	Jen	Feb	Mar	Apr	Mey	Jun
Recorded events	1176	1004	890	582	673	211
Fell events	234	216	162	92	121	32
	Jul	Aug	Sep	Oct	Nov	Dec
Recorded	601	486	620	413	604	572
Fell evsnis	112	82	108	69	106	94

The rate of uplift of the 'New Mountain' cryptodome decreesed through 1980, from 5 cm/day in Jenuary to 3-4 cm/day in December (Figure 4). Northward lateral movement of the northern flank continued at e similar rate. As a result, compression of the ground north of the volcano also continued, effecting several towns and villages.

Intermation confacts: Seismological Division, Japen Meteorological Agency, 1-3-4 Otemachi, Chiyoda-ku, Tokyo 100, Jepan.

I. Yokoyama, Hokkaldo University, Sepporo, Japan. Volcenic Activity in Nicaragua—early 1981. The following le a report from Richard E. Stolber and Stenley N. Williams

liems.
Scientiets from Dertmouth College, the Nicareguen Institute of Natural Resources end Environment, end the Nica-

(News cont. on pege 111)

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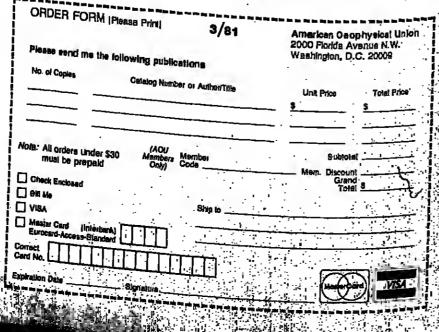
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(News cont. from page 109 )

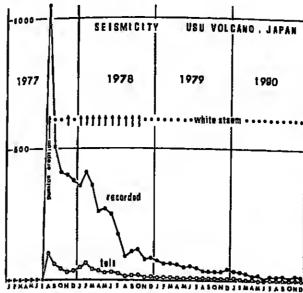


Fig. 4. Monthly averages of the number of recorded (solid circles) and fait (opan circlea) salamic avants par day at Usu, August 1977-Decembar 1980. Explosiva activity during a perticular month is indicated by arrows.

raguan inatilute of Selemic Investigations observed Niceraguen voicenos during a 3-week period in Jenuary and early

Meseye (11.95°N, 86.15°W): The ges emission event thel began in Iail 1979 continued with a steady release of very large amounts of SO2. Strong winds carried the ges niume onto populated areas at high elevations. A day of noieble rockfall activity in the crater was followed for 1 day by a significantly larger rate of gas release.

Sen Cristóbal (12.70°N, 87.02°W): The gas plume releesed assentially continuously since gas emission began in 1971 has become Intermittent. Periods of energetic gas release of less than 1-hour duration were separated by perioda (messured in houra) ot onty low lumarolic release. Shallow seismic activity conlinued at levels above back-

Telica (12.60°N, 86.87°W): A small-votume plume of vepor was intermittently released. Shallow seiamicity was regularly observed in the vicinity.

Momotombo (12.42°N, 86.55°W): A small, continuous vapor plume was visible. No shallow seismicity was obeerved around Momotombo.

Information contects: Richard E. Stolber and Slanley N. Williama, Department of Earth Sciences, Dartmouth Colege, Hanover, NH 03755.

Debble Reid de Jerez, tRENA, Managua, Nicaragua. Douglaa Fajardo, IIS, Managua, Nicaragua.

# Earthquekes

Deta	Time, GMT	Magnituda	Ragion
Jan 4	1447	4.2mb	wastern Graanland
Jan 18	1817	6.7 Ma	near eest coast of Honshu, Japen
Jan 19	1511	8.8 Ma	Waat Irlan, Indonesia
Jan 23	0458	8.1 Ma	Hokkaldo, Japan
Jan 23	2114	7.0 Mg	Sichuan, China
Jan 23	2155	7.1 Ma	Attantic-Indian Risa
Jan 30	0853	8.9 M <sub>B</sub>	Raf lalands, Aleutlans
Latitude	Lor	ngltude	Depth of Focus

Latituda	Longitude	Depth of Focus
76.92°N	87.33°W	shallow
38.69°N	142.83°E	40 km
4.60°S	139.30°E	ahallow
42.85°N	142.15°E	ahallow
30.97°N	101.14°E	22 km
29.73°S	60.75°E	10 km
51.57°N	178.39°E	ahallow

The west Greenland earthquake caused small cracks to the south southeast at Savigsivik. The January 18 event regleterad 2 on the Japanese Meteorological Association ecele in Yokohama and waa felt in northern Honshu and southern Hokkaldo. The West Irlan ahock, and landelides triggered by it, killed 261 persons and caused much destruction in the Jayawijaye Mountains, on the southern edge of the central highlanda. The January 23 Japanese earthquake was the second and atrongeel of three that day on Hokkaido. It was felt from the Kurlle Islanda to Tokyo, but no serious damage was reported. The Chinese earthquake on the aame day in the Dawu district of Sichusn province killed fewer than 160 persons but caused exiansive damage to dwellings and roads. The January 30 event centered near the Rat lelande wae widely lelt throughout the western Aleutiena, though only lightly on Shemya laend 150 km to the weat.

information contacts: V. F. Buchwald, Department of Melallurgy, The Technical University of Denmark, Building 204, 100 Lundtoftevej, 2800 Lyngby, Denmark. Tokiko Tibe, Department of Geology, National Science Museum, 3-23-1 Hyakunin-cho, Shinjuku-ku, Tokyo 160,

National Earthquake Information Service. U.S. Geological Survey, Slop 987, Denver Federal Center, Box 25046, Denver, Colorado 80225 USA.

Agence France-Prasse. United Prees International Firebells

Weelem Austria, December 28, 1980, 221814 GMT. The ollowing la a report from Zdeněk Cepleche.

A firebell of -13 maximum ebaolule magnitude wes photographed by severel Czech and Germen stations ot the European Firebell Network. The fireball traveled e 27 km trajectory in 1.3 seconds. The tollowing preliminery results are based on the first four available photographs from distant stations (330 to 480 km

	Beginning	Maximum Light	Tarminal
Velocity (km/s)	22	21	18
Halght (km)	92	79	89
Latituda	49.95°N	47.02°N	47.07°N
Longituda	10.65°E	10.59°E	10.55°E
Magnituda	-4.2	- 12.6	-4.5
Mass (kg)	29	1 <b>a</b>	попа
ZR	33°	33°	33'

#### Firsball typs: III R viataorila tali impossible

Ascanding node

Radiant (1950.0)	Obsarved	Geocentric	Hallocantric
Alpha	99°	89°	
Delta	17°	15°	-
Lambde	_	_	40°
Beta	-	-	- 5°
initial Valocity (km/a)	22.4	19.3	35.5
Orbit (1950.0)			
A	1.9 A.U.		
E	0.63		
0	0.59 A.U.		
Aphellon	2.6 A.U.		
Omaga	91°		

Intermation contact: Zdeněk Ceplecha, Ondřejov Observatory, 251 65 Ondřejov, Czechoslovakla.

Burme, November 2, about 1130 GMT (about 1800 local tima). Elizabath Crowder saw a brillfant Irreball just alter sunsel from Pagan, about 200 km southwest of Mandalay on the Irawaddy River. Walking southwast along an unlit streel, she noticed the sky brightan as it a street light had been lurned on behind her. She turned and observed a brilliant tireball with a rounded red and blue head and a long, yellow, arc-shaped tall. The object movad from almost directly overhead loward the northeast. Illuminating the sky like a lerge lightning bolt. It disappeared above the horizon without a terminal explosion. No sounds were associated with the lireball, which was visible for 5-10 seconds

Information contact: Elizabeth Crowder, t33 Mepache Drive, Portola Valley, CA 94025.

Wast Germany, December 23, 2047 GMT. Observers: Cept. Bruns and F/O Raulf of Lufthensa Ilight LH 263 (Vianna-Dusaeldorf) Location: 15 km NW of Erlangen (40 km NW of Numberg), aircraft course 315 magnetic, altitude

First eighting: 045 magnetic, 10 above the horizon Last sighting: 035 magnetic, at the horizon

Duration: 18 Apparent brighinees: As bright as the full moon Color: Green/yellow-white

The tireball first appeared as a green line, then separated into three yellow-white 'slars.' Information contact: Gerhard Poinitzky, Universitaats-Sternwerte, Tuerkenschenzstraese 17, A-1180 Wien, Aus-

New Zealend, October 17, 1980, 2242 GMT (18 October, 1042 Naw Zealand Slandard Time). Mr. and Mrs. T. D. Wenborn reported that while they were eliting on the beach at Ruby Bay, near Nelson, at the north and of South leland on Tasman Bey, lhey noticed a vivid while trail forming behind an invisible object moving at great speed. The trail extended from the east northeast alde of the zenlih back to the east northeast hortzon. In 3 aeconds the object traveled to 45° above the weat aouthwest horizon, where II was lost In cloud. There was no sound during the passage overheed, but only 3 or 4 aeconde later they heard a muffled dull explosion. The Wenborns remained on the beach tor another 15 minutes, then continued their frip northweel. After driving for 10 or 15 minutes they observed the end of the trail. It ferminated in a cloud like structure with five or

six similar tralla leading from if. No other observers are known. The DSIR Geological Survey branch had no eeismic record of the event. Air Traffic Control at Wellington showed no alreraft in the vicinity during Ihle period. Lincoln Tempero, Naval Altaché, New Zealand Embassy, Washington, D.C., reported that no milltary meneuvera were underway. The New Zealand Meteorological Service is researching weather conditions at thia

The Meteor Section of the Royel Astronomical Society of New Zeslend is investigating the event and will provide more details when they are available.

Information contacts: Ken I. Morse, Director, Meteor Section, Royal Astronomical Society of New Zealend, P.O. Box 2241, Wellington, New Zesland. Lincoln Tempero, Naval Attaché, New Zeeland Embeaav.

37 Observetory Circle, Washington, DC 20008. Oman, January 20, 2028 GMT Observers: Capt. Habegger and F/O Moser of Swiasair flight SR 197 (Bombay-Athene) Location: 23.90°N, 57.25°E, aircraft course 280° magnetic, eltilude 8.5 km

First sighting: 200° magnetic, 10° ebove the horizon Lest sighting: 200° magnetic, at the horizon

Apparent brightness: Dezzling Color: Writte/blue

The firebell appeared as point without a tall, first white, then blue. There was no flickering.

Information contact: Gerhard Pointtzky, Universitaets-Siemwerte, Tuerkenschanzetrasse 17, A-1180 Wien, Aug-

Weelern Pennsylvania, USA, 1 January, 1810 GMT (1310 Eestern Stendard Time). A daylight fireball end a loud explosion occurred over western Pennsylvenia on New Year's Day. The pllot of TWA tlight 83 reported to Cleveland Air Traffic Control el Oberlin, Ohlo, that he was el 9.5 km over the Somereet, Pennsylvanie, FAA beacon end was eeeing a 'bell of flames, like magnealum on lire' telling elraight down in front of him. Two other airline pilota reported similar sightings to Cleveland when they entered Cleveland's air epece about 20 minutes later: to the northwest from ovar Martinsburg, West Virginie (Northwest Orient tlight 89), and to the north of Pitteburgh from over Charleaton, Waat Virginia (Eestern flight 140). A general aviation pilot reported later in the day that he had seen a lireball ebout 1310. There were no sighlings from the ground beceuae e heavy snow atorm was in progress.

The explosion was heard and talt about 1315 over a region Irom Allegheny County north to Warren County. Seismic effects included vibrations, ground shaking, and cracked windows. The North American Air Defense Command (NORAD) hed predicted no reentrice for this time and location. Paul Oles, program director of the Buhl Planeterlum and Institute of Popular Science in Pittsburgh, suggested that e 'Iraglie meteorile' might heve tellan. No meteorila pleces have been reported recovered.

Information contacts: Don Anderson, Cleveland Air Traffic Control Center, Oberlin, OH.

Paul Oles, Program Director, Buhl Planetarium and Institute of Popular Science, Aflegheny Square, Pittsburgh, PA

NORAD/OPI, Pelarson AFB, CO 80914. United Press International.

# **New Publications**

Glossary of Geology, 2nd Ed. R. L. Bales and J. A. Jackson (Eds.), American Geological Institute, Falls Church, Virginia, x + 749 pp., 1980, \$60.00.

Reviewed by Rhodes W. Fairbridge

A review of a glossary can hardly follow the usual lines for a monograph or textbook. The authorship is multiple, though alrongly edited, and the atyle is inevitably dry and the organization is alphabatic. (In tarms of subjects, essentially randoml) I cannot claim to have read it cover to cover.

Nevertheless, it is a superb voluma, and every serioua aarth scientist will have to possess his or her own copy. The prica is a bit steep, but that's how the costs are running these days. This is called a second edition. The first A.G.I. Glossary was in 1957, covering 14,000 odd terma. A paperback selection appeared later. In 1972 came a completaly naw work with 33,000 terms; now the present volume, a rigorous revielon, which by strict discipline and closa editing has been kapt down to 38,000. Notable expansion has been in auch areaa es plate tectonics, paleomagnellam, seismic stratigraphy, and remote sensing. Another 450 new mineral names appear, adding to some 4000 already recorded.

The acope of the glosaary is geology and geophysics in the broadest connotation and reaches the interfaces with archeology, estrogeology, climatology, oceanography, and soil science. Dipping into the book generates a salutary agnse of awa. What a vast eclence we have generated. In apite of the Impressive recent advances in quantitative data acquisition and analysis, the great bulk of earth science must be verbally described. Some of the terms are remarkably disaming. You may snigger, it so inclined, over 'coal amut' or be envioua over 'hog wallow.' And what is 'lumpy '? (It is e badly cut gematone.) ii you deal in earth hielory, you ahould not conjuse 'lower' with 'early.' Acronyms, et least 100 of them, range from MSL to the LVL. Geodesiste will miss RVCM (recent vertical crustal movementa). Some rather controversial terms are treated with varying agility. 'Geosynclina' ferea much batter then 'geocline.' Various laws, familiar and otherwise, alao get mixed attantion: Sloke'e Law and Sternberg's Law do fine, but Snell'e Law needs a bit of help (students of beach erosion really need thia). Some extraordinary and unexpactad synonyma amerge: thue, 'orthid' is both a kind of soil and a family of Peleozoic brachlopoda; I gueea you would lell which by the context. And 'geo-' of courae meene anything to do with the earth, but 'geo' (no hyphen) meane a chasm in Old Norae. I counted exactly 100 'geo-' worde before getting geold, which would be a good 'datum' on which to close.

But as an afterthoughf, by the way, if you entoy guessing games, each of the elphabelic heads is accompanied by an untitled geo- photograph. If there is an earth eclentlet who. can identify the whole lot. A through Z, I'll be happy to buy him or her the drinks (no cheating now, there is a list somewhere). I'm eure we will atl join the davoted editors, Julia Jackson and Bob Bates, in saying 'Thenk You,' and hopewith them that the glossary will prove to be 'a bulwark against the babelization of the geological language."

Rhodes W. Fairbridge is with the Department of Gaological Sciances, Golumbia University, New York, New York

lame listed in New Publications can be ordered directly from tho publisher; they are not available through AGU.

Advences in Geophysics, vol. 22, Estuarine Physics end Chemistry: Studies in Long Island Sound, B. Seltzman (Ed.), Acedemic, Now York, xiv + 424 pp., 1980, \$44.50. American Geological Literature, 1669 to 1850, R. M. Hezen and M. H. Hazen, Acadomic, New York, xii + 431 pp.,

Cetastrophic Flooding: The Origin of the Channeled Scebland, V. R. Beker (Ed.), Dowden, Hutchinson & Ross, Inc., Stroudsburg, Pe., xlli + 380 pp., 1981, \$40.00.

Eerthlike Pienets: Surfaces of Mercury, Venus, Eerth, Moon, Mars, B. Murrey, M. C. Melin, R. Grseley, W. H. Freeman, Sen Francisco, Celli., xiv + 387 pp., 1981. Geodesy, 4th ed., G. Bomlord, Clersndon, Oxford, xll +

Hot Dry Rock Geothormal Energy Development Program, G. M. Cramer, R. B. Duffield, M. C. Smith, and M. G. Wilson (Eds.), Los Aismos Scientilic Laboretory, Los Alemos, N.M., viii + 248 pp., 1980.

Map of Significant Eerthquakes 1900-1979, Netlonel Geophysical and Solat Terraetrial Deta Center, Boulder, Colo., 1980. Avsilebla Irom NOAA, Bouldsr, Colo.

Physical Oceanography of the Tropical Atlentic during GATE, W. Duing, F. Ostapoff, J. Merle, Kingsport Press, Kingsport, Tenn., x + 117 pp., 1980.

Geophysical Monograph 23 New !

# The Tectonic and Geologic Evolution of Southeast Asian Seas and Islands

Dennis E. Hayes, editor (1980)

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For luther information write or call Alva Lisen-bee, Dept. of Geology and Geol. Engr. South De-kola School of Alines & Technology, Rapid City, SD 57701 (805-394-2481).

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The appointee will normally be attached to the ANU Radiocarbon Laboratory and will work in collaboration end co-operation with its Head, H. Po-lach, and its stell. The appointee will be responsible for the exponsion of the laboratory to meet the in-creased needs of the R.S.E.S. Environmental Geo-

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spipo annient at research Onicar Grade 2 level would be considered for an appropriate applicant. Salary on appointment will be in accordance with qualifications and experience within the following Research Officer Grede 1: \$15,300-\$19,125

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Further details of the post ere evaleble from Dr W Compation, Research School of Earth Sciences.
Reasonable appointment expenses are paid. Return lares may be eveleble to an appointee from overseas who holds a limited term appointment and assistance with accommodation with the provided to ore-seas who notes a innied term appointment and assistance with accommodation will be provided to the successful applicant. The appointmental be required to undergo a medical examination.

Written applications, quoting reference number e1142, should be forwarded to the Secretary, The Austrelian National University, P.O. Box 4, Canberte A C T. 2800, with whom applications close on 24 April 1981. Receipt of applications will not be

24 April 1981. Hiscorpi or appropriate and acknowledged unless requested.

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Hydrogeologist. Applications trivited for a per-manent laculty position. The position requires a Ph D , teaching at graduate and undergraduate layels, supervision of research, and research in area of speciarry Interaction with faculty in surface water hydrology, stobis-isotope geochemistry, geophys-ics, and sod-mentary geochemistry is expected. Condidates should send resume selected. Search internst, and addresses of three references to L D ArcO nnis. Cheirman, Department of Geology. Northern Illinois University, DeKnib, IL 60115. nd resume, statament of re-An equal opportunity effirmative action employer

Selamologist. The Department of Geology st the University of Unions, Urbane-Champaign, has an opening for a tenura track position at the assistan opening for a tenura track position at the assist-unit professor level, beginning during this 1981–82 academic year. A Ph D. Is required. The applicant should have a strong background in goology, and post-foctatate exponence is desirable. Candidates with interests and experience in tectoric attidies based on setsmological observations will be given praference. This successful candidate is expected to develop an activo research program to comple-ment axisting programs in geodynamics, solid earth in develop en activo research program to comple-ment axisting programs in geodynamics, solid earth geophysics, and rock physics. There is also oppor-tunity for interaction with programs in the Depart-ments of Theoretical & Applied Mechanics, and Chrif Engreeving, and the Interdisciplinary Materials Re-search Laboretory. Send resume and names of three references to: Dr. John Hower, Head, Depart-ment of Geology, University of Illinois, 245 Natural History Bidg., 1301 W. Green St., Urbana, It. 61801 (Felephone: 217:333-3342), Applications should be received by April 16, 1981.

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Exploretion Ge ophysicist/University of Gklahoma. The School of Gaology and Geophys-ice at the University of Oklehoma will hire an experice at the University of Commona with nire an experienced exploration geophysicial to fill the Frank and Betty Schultz Professorable, and is seeking nominetions and applications for the position. The person must be a distinguished ecleritist who has made important contributions to exploration geophysics through research. Ordersones will be along hysics through research. Preference will be given prysics through research, Preference will be given to a scientist whose specialty is selemic properties of earth materials and who has earned the Ph.D. The Schultz Prolessor will provide leadership end guidence in establishing a quality teaching and reguidence in esteblishing a quality teaching and re-seerch exploration geophysics group. The Universi-ty of Oklahome has recently made a strong com-mitment to the earth sclances with the establish-ment of a College of Geosciences, to be housed in a new building. The School of Geology and Geo-physics will expand from its present faculty of 19 to 28 laculty members by 1988. This will include three scientists in the exploration geophysics area, the in-

25 laculty membera by 1988. This will include three scientista in the exploration geophysics erea, five in siructure-tectonophysics-solid earth geophysics end others in stratigraphy-paleontology, geochemistry-petrology, and energy resources.

Applications are due April 30, 1981. Inquirtes, nominations, and applications should be sent to John Wickham, Director, Behcol of Geology and Geophysics, University of Oklahoma, Norman, OX 73018.

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The auccaseful candidate must have the following attributes: demonstrated creativity and promise of excellence in research and teaching; intent to develop a vigorous gradueta research program; de eire to teach courses in fiald of interest and related fields of geoscience et undergraduete and graduate

este, and namee of at lasel thrae reterances, to Larry Heskin, Chairman, Dapartment of Earth & Planetery Sciences, Washington University, St. Louis, MO 83130. Applications received through

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Sand resume, statement of future research inter-

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seeking a person with a broad background in oceanography and one or more of the related earth ocianography and one or more of the releted actuscience fields such as marine geology and/or sedimantology. Mejor reapone/bility will be teaching beimantology. Mejor reapone/bility will be teaching beginning and advanced courses in coesanography,
courses in the related field, and general education,
courses. A modast amount of research is possible
and as a necurrant Applicants about a presser the and is ancouraged. Applicants should possess the Ph.D. degree or be in the final alages of completion of that described the control of the co of that degree. Starting rank and seleny will depend on experience and other quellifications of the candi-

Applicants should aubmit a resume and at least three letters of recommendation to Dr. L. Glan. Cabb, Chalman, Department of Earth Sciences, University of Northern Colorado, Greeley, CO 80839

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deadline le April 15, 1991. Position

applied to groundweter ayetems end numerical analysis techniquas to desired.

evailable April 30, 1981. Se'ery le negotiable.

1803-656-3278).

mative action employer.

Research Fellow: Aqueous Solution Geoohemfatry. The Australian Netional University invites applications for appointment to the position of research fellow—aqueous solution geochemistry, in the Research School of Earth Schencas from those

holding a Ph.D. degree to a relevant flaid.

The Research Bohool of Earth Sciences has recently established an interdisciplinary res group in anvironmental geochemistry. Current areae of rasearch include application of stable iso-tope studies and radiochemistry, to the geochemi-cal evolution of the Great Berrier Reef, the Guif of Carpenterie and the geochemical record contained in the sediments of Australien Inland lekes. Special ettention is elso being devoted to holocene pa-lasoclimetology and the carbon cycle. This group wishes to eppoint a research fellow specializing in aqueous solution geochemistry to work on a col-laborative besis on research projects in the above

in edition to perticipeting in collaborative re-search progrems, the appointee will have the op-portunity of pursuing independent research in generel areas of interest to the group. The geochem cel environment of Austrellan Inland lakee end groundweters is of particular Interset and the ap pointes ahould be prepered to participete in a major research program aimed et understanding the solution, transport and precipitation of chemical species s aqueous solutions end sedments A wide range of evaporate minerals are known to occur in these begins at the present time

Consequently, the research undertaken by the successful applicant may have implications not only to environmental geochemistry and pelacoclimatology but also to economically significant topics such as the mobilization, lixation and migration of metals

and other elements of economic significence.

Applicants should heve broad interests in geochemietry, together with e strong background in theoretical solution geochamistry and relevant ex-perimental-chemical techniques. In addition to deaubmit rasearch proposals detailing the general re seerch directions and specific projects which they would wish to pursue. Further information concern ing the position can be obtained directly from Or.

Salary on appointment will be in accordance with qualifications and exparience within the range. Research le flow \$19,132-\$24,972 per annum. Appointment will be for 2 or 3 years in the first in atence with the possibility of extension to live yeers. Superannuation, housing assistence, res-

sonable eppointment costs. The University reserves the right not to make an appointment or to make an appointment by invitaet any time. No lixed closing date is spacified

for the above position.
Interested cendidates ere requested to submit their applications to The Registrar, Australian National University, PO 60x 4, Canberra, ACT 2600,

Rasearch Pleama Physiciet. Must be eligible for Ph.O. In pleame physics with specialization in and abstracts presented on theory end numerical almulations of magnetic sheer effects on instability phenomane es epplied to lonospheric and magnetospheric problems. 1 year work experience in the field is required. Poetflon opening in D.C. eres. Salery \$24,415 per yr., 40 hrs. per wk. Please report with ad to Virginie Employment Commission, 9320 Castle Piece, Falla Church, VA, and refer to iob order no. 346643.

Senier Hydrogoologiet. Fred C. Hert Associates, an environmental consulting firm, is providing technical assistance to the U.S. Environmental Protection Agency in their efforts to discover and iden tily hazardous waste sites, evaluate their impacts and design site clean-up measures

An opening exists for the position of senior hydrogeologies in our Newark, N.J. office. The succesaful and in the responsibility of the content of

Candidates should possess an M.S. degree with five years field experience in hydrogeology, or B.S. degree and seven years field experience in groundme to: Fred C. Hart Associates, Inc. 155 Washington Sfreet, Newark, N.J. D7102, Att: Amelia J. Jan-

Research Associate. Position available July I for new Ph.D. scientist in climatology-glaciology. Work involves research in ica-climate synoptic in-Work involves research in localistic imagery teractions based on analysis of satellite imagery and digital data (Nimbue and DMSP systems) of climatological and cryospheric parameters using multivariate statistical techniques. Research is performed in a cooperative university/gov cratory amploying scientists engaged in Interdisciplinary work related to the environment. Position requires experience in analysis and dis-

Position requires expending at analysis of the services ing; demonstrated ability to write solentific reports; background of gleciological-meteorological field research in polar areas; experience in interpretation of anow cover, sea ice, and cloud conditions from of anow cover, sea ica, and cloud conditions from visible, IR, and ESMR miorowave integery and digital date; experience with multivariate statistical analysis techniques, especially as applied to materoriological or related deta; experience in FORTRAN programming in a COC Kronos or NOe operating environment; and research experience in synoptic climatology and los-dimata interactiona.

Baláry approximately \$17,000/year, Applications including vitae and three references should be addressed to Dr.; R. G. Barry, CIRES, Campus Box 449, University of Colorado, Boulder, CO 803005.

The University of Colorado, Boulder, CO 803005.

The University of Colorado, Boulder, CO 803005.

tylesiomative action employer.

Patrology/Gaschemistry, University of New Brunswick. The Depertment of Geology has a tenure track position available from 1 July. t991, at assistent professor or higher level. The successful epplicant will be expected to teach both undergraduetes and graduales as well os carrying out reseerch and supervising graduete abudonte This position is in eddition to ona currently adverfised for a rock mechanic or geochemist

The epplicant should have a background in panistry and petrology and should be prepered to teach in some aspecta of petrology and goohemistry. The successful applicant will be respon able for supervision of analytical tecllities including

Applicents should have a Ph.D. end praierably, post doctoral experience. Applications including a curriculum vitae and nemes of three raferese should be sent to P. F. Williams, Cheirmen, Department of Geology, University of New Brunswick, Frederiction, N.O. E30 5A3.

Qaophysiolst. Applications invited for a tenure track position at the essiatent or essociate profes-sor level, beginning August 1981. Succassful candi date will be expected to develop greduete courses in area of experise and to teach undergraduate eophysics. Although all areas of geophysics will be considered, preference will be given to profes-sionals with teaching and research interests in soiamic stratigraphy and petroleum exploration.

Departmental equipment includes a refraction.

selsmograph, resistivity meter, gravimeter, megne-tometer, porometer, and permameter. The candidate will have the opportunity to substantially add to his or her equipment nee ant computer iscilitios includa e DEC 10 and

an IBM 360-44, while a PK 3240 system with 19 negabytes capacity is under developm ODU is a state-supported university arted university serving nearly 15,000 students and is situated within the secity Hempton Roads metropoliton nroa that is na-tionally known for its historic, recrontional, and cul-

lural lacilities. Selory commonsurate with exponence and qualifications. Send vitae, a brief discussion of research interest, and arrenge to heve three letters of reforence by April 10, 1991 to Cennie A. Dorby, Chair man, Department of Geophysical Sciences, Old ion University, Norfolk, VA 23509 An elfirmetive action/equal opportunity employo

Faculty Position in Physical Decembersphy. The Department of Merine, Earth and Atrocspheric Sciences at North Ceroline State University tenure treck position at the assistant or nesociate asor level for a physical oceanographer, spocisilizing in the numerical modeling of oceanic

Applicants should have a strong background in geophysical fluid machenics and the abilities to davelop a funded research program and graduate level courses Presently lunded areas et NCSU include estuarine, coastal and deap-water oceanog-

Send curriculum vitae and the names of three relerences by March 31, 1981 to Professor G S. Janowitz, Chairman, Saarch Committee in Physical Occanography Department of Marine Earth and Almospheric Sciances, Nonh Carolina State University, P O. Box 5068, Releigh, NC 27650. North Cerolina Stats University is an equal opportunity/affirmative ection employer

Purdue Univarelty. A tanure treck appointmant in the erea of surveying and mepping Under-graduate teaching in the arees of basic surveying. edjustment computations, and introductory photo grammatry photo interpretation; thyolvement in seaching graduate level courses, and in existing and new research programs

Preferentiel consideration to cendidates with a

Ph.O. and land surveying registration (or in tha process of getting such degree and registration); ank end salary are open and dapend on the axperience and qualifications of the applicant. Bohool of Civil Engineering, Purdua University West Lafeyette, IN 47907.

Directors Mateorotogy Division, Air Porce Geophysics Leboratory. Air Force Osophysice Laboratory invites applications for the position ol Director of the Metcorology Division focated at Henecom Air Force Basa, Maseachusetts. The Division la responsible for Air Force rescerch and development in meteorology, etimospheric physics, ra-mote and direct aensing lechnology, climatolopy, and relative technologies. The division director pro-vides overall direction to an R&D program which amploys over 8D people and covers a broad ronge of in-house and contractual sciantific investigation. A candidate should have a record of distingu echievement in meteorology/atmospheric physics es e research eclentist end manager of a substan-

application package, call collect: Robert Ellerin. (617) 861-2899. To be considered, applicatione muel be returned by 30 April 1981 Equal omployment opportunity employer.

tial R&D unif. This position is Air Force Senior Ex-

ecutive Service with a salary range of \$52,247 to \$57,973, subject to current \$50,112 ceiling. For an

Rasearch Associate: Colorado Biele Univereity. The Depertment of Civil Engineering.
Colorado State University, Hydrology and Water
Resources Program, invitas applications for a position as research ossociate. The initial eppointment is for two years with the possibility of extension bayond that period.

The epplicants must have an M.S. with a beck-ground in hydrology, groundwater hydrology, or wa-ter resources. An interest in the erees of flow through perous media, stream-aquitar interaction, end groundweter modeling is desired. Preference given to poisons with experience or strong into osi in numerical onalities tochniques and modeling usinp digital computors.

The successful applicant will become a member of a research group actively involved in both basic and epptied research on conjunctive inanegement of surface and groundwater

Application closing date: April 15, 1991. Position available April 30, 1991 Salnry le negotiable Send opdication with resumo, gradunts under graduate linnscripts, and names of two references to Dr. H. J. Morel-Soyloux, Chairman of Seerch Committoe, Doportmont of Civit Engineering, Coloredo Stato University, Fort Colline, CO 90523, (303) 491-9549 or (303) 491-5448

CSU is EED/AA employer E O Difico 314 Studant Services Building

Chemicel Decenographer. Research easocinio, M.S., marine organic geochomistry and its re-lation to ocean productivity. Cooperative institute of Merine and Almospharic Scionces, University of Mi-ami and National Oceanic and Almospharic Adminstration, contect Chairman Search Committee

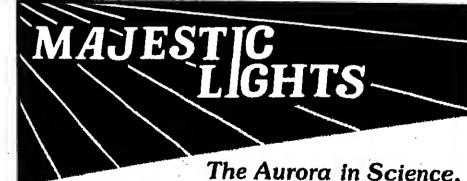
O. K. Atwood, NOAA ADML, 15 Rickenbacker

Feculty Appointment/Coloredo State Univeratty. The Dapartment of Earth Resources. Colorado State University mvitae applications for a lenure treck appointment with amphasis on active reeasich experienca in lamete sensing, and an intarest in teaching graduato and undergraduate students baginning Septembar 1981. The candidate is axcted to have a Ph.D. degree in geology, watershad 3Ciances of in a related half and in expected to davalop and maintain a vigorous research program with special amphasis on the application of stale-cl-theart remota sansing techniques to the investigation of naturel resource phenomens. The candidate is axpected to lasch undergradusta and graduate courses in the application of remote sensing to natu-

Rank and salery are open and dependent on experience and qualifications of the applicant.

Applicants are invited to aubmit curriculum vites. three letters of raterance and a fattar describing re-search and teaching interests to Or. H. S. Boyna, Da-pertment of Eerth Resources, Colorado Stets Uni-versity, Fort Colline, Cotorado 80523/(303) 491

Deadlina for receipt of applications is April 15, CSU is an EDE/AA. E.D. Office: 314 Student Serv.



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Faculty Position/Synoptic Meteorology. The University of Maryland invites applications from qualified scientists for a toriura track faculty position el ina assistant or associate prolossor tevel, com nancing tell 1981. Condidates must have a Ph O in meteorology or releted oross and hevo an area of specialization in synoptic and dynamic meteorology. Teaching experience is desirable. This successful candidate will be expected to teach primarity graduate fovel courses in synoptic molecrology and carry on an active rosearch program Sn'ery will be commansurate with quelifications and axpa-

All epplicante abould send curriculum vitaa, o brief etalement of research interests end names, eddressos and telephona numbers of three professional references to: Protessor Fardinand Baer, Chairman, Oppertment of Molecrology, University of Maryland, College Park, Moryland 20742. Closing date for applications is April 15, 1981 The University of Maryland is on equal opportuni-ty/offirmative action employer.

Feoutity Opening. The Department of Geological Sciences of the Steta University of New York of Albany livites applications for a fertura track faculty poolition which will be ovaliable from September 1, 1981 at the assistant pratessor level for a research crionted scientist to join a department with orionled sciontist to join a department with etrengine in etructural geology, teclorics, geocham-istry end petrology. Applications are invited from geologists, geophysicists and geochamists with Ph.O. degrees who leel qualified to comploment or augment studies in these fields. Salary will be negoliabla Letters should be addressed to: Prolessor Kevin Burke, Chairman, Ospanimeni of Geological Sciences, c'o Personnel Depariment, State University of New York at Albeny, Albany, N.Y., 12222. SUNY at Albany is an equal opportunity/affirmaive action employer. Applications from women, miwritiae end handicapped era especially welcome.

COURSES

MSA Short Course on Kinelios of Geologic oel Processe. The Mineralogical Society of morica will sponsor a shoul course in Kinetics of Oeological Processee, prior to the 1981 AGUapriz Meeting in Saltimore, Maryland, This short course. Meeting in aaltimore, Maryland. This short course, organized by Tony C. Lasage and R. James Kirkpairick, will be held from Mey 22-24. Speakers and topics to be included are: intraduction to Rate Theory-Global Kinetics-Geochemics Cycles, Antonio Tony Lasage Pages death of Stotal Institute 1 Tony Lasaga, Panasylvanio Siele University, irreversible Tharmodynamics in Petrology, George Fishar, Johns Hopkins University; Diffusion, Oevid Anderson, University of tilmols; Transilion State Theory and Defect Structure of Bilicates, Tony C. Lesage. and betect Structure of Billicates, Tony C. Lasage, Pennsylvania State University: Kinetics of Nuclestion and Growth in Igneous Processes, R. James Kirk-patrick, University of Ulinole; and Kinatics of Weath-ering and Ologanesis, Robert Berner, Yele Universi-ly For additional Information and registration forms, contact MSA, 2000 Floride Avenue, N.W., Washing-ton, O.C. 20009 (tolephone: 202/482-6913). Regis-tration deedline: March 31, 1981.

Ground Water Modelling. Workehops in Ground Water Modelling are scheduled to be held this epring of the Holcomb Research Inetitule, Buter University, Indianapolis, Indiana. The workshops leature the institute's International Clearinghouse for Ground Water Models, which aloree over \$80 computer annotations of graund water models throughout the world. The workshops, co-sponsored by the National Water Well Association. sored by the Nestone weter west Accordance, range in complexity from basics in computer modeling to edaptation of the Pricket/Lonnquist Modeling to edaptation of the Pricket/Lonnquist Modeling Catact for the 1981 workshops are as lossws:

Part I: An introduction to Modeling Ground Water Flow and Tronsport, May 27-29; Part II: Methematical Foundations and Computer Implementation of Carusel Water Medicaling, Impa 1-5; Part III: Applied. Ground Weter Modeling, June 1-5; Part III: Analytical Ground Weter Modeling, Mey 18-22; Part IV: Adaptations of the Prickett/Longuist Model, June 8-12

Instructors for Parts I and II are Drs. James Mar-cei and Charles Feust, GeoTrens, Inc., P.O. Box 2560, Reston, Va., 22090, Telephone (703) 435-4400. Instructors for Perts III end IV Include Thomas A. Prickett, Special Consultant to Cemp Dresser end McKee, Inc., and Wittlem Watton, Camp Dresser er end McKee, S02 E. John St., Suite 1700, Chemer end McKee, 302 E. John St., Sulte 1700, Chem-paign, II., 61820, Telephone (217) 384-4374, For more information on course content, contact instructors. For more information on workshop ec-commodations, logistics, atc., contact Annaballe Peul or Richard Hyde, Holcomb Research Instituta, Butter University, Indianepolis, tr., 46208, Tela-phone (317) 283-9555 by April 30, 1981.

Course No. 401: Invareion Methods in Remote Soneing, Alexandria, VA. MAY 18mote soneing, Alexandria, va. MAT 18-22, 1981. The course is intended to provide a basic understanding of the concepts and an over-view of applications of the increasingly important field of inversion methods in remote sounding and le structured to benefit those involved in the theoreticel, experimental, deta analysis, end manage mani aspects of ramote sensing experiments to ment aspects or remote sensing experiments to monitor the almospheric constituents and properties from ground, shibome, or apace platforms. The advantages, limitatione, and future prospects of each technique will be discussed. Instructors will be Oro. M. Chehina, B. J. Conrath, A. Despak, B. M. Hermen, W. L. Bmith, O. H. Staeth, and E. R. Westweter. Replatration less le SAGGO.

Westweter Registration tea le \$460.00.

A Certificate of Course Completion will be awarded to those who complete asch course. For further Information, contact: Nancy Reynolds or Sue Cratts, Course Coordinators, IFAORS, P.O. 80x P. Hampton, Virginia 23668 (Tet: 804/827-5611).

#### SERVICES

**Geophysics!** Historian. A historian of geophysics, apecializing in asiemic investigation of the Upper Mentle and preparing state-of-the-ert reviews on perticular questions in the field. Hee a doctoral degrae from the USSR Acedemy of Sciences Institale for the History of Science and Technology.

Was a senior aditor and researcher at the Soviet
Geophysical Committee in Moscow. Hes written s monograph , many articles in her field, as well as added over 60 books. Contact E. Millutina, 111 Ellwood Street, apt. 5E, New York City, NY 10040.

# Meetings

# **Understanding Basin Hydrology**

A symposium on the understanding of hydrotogic procossos at the basin scale will be held at the Universidad SImón Bolívar in Caracaa, Venezuela, January 11-14, 1982. The elm of the symposium is to eesess the present understanding and to explore new research avenues for climatebasin Interaction, hydrologic response, coupling of geomorphology and hydrology, parametarfzetion of hydrologic processos, and robustnoss of catchment modeling.

The symposium will be convened by the university'a gradualo piogram in hydrology end water resources in cooperation with the International Association of Hydrologi-

For edditional information, write to Ignacio Rodriguezllurbs, Universidad Simón Bolivar, Apartado Postel 80.659, Caracas 1081, Venazuela.

# Basaitic Magmatism and Voicanism

A meeting to discuss the Generation of Major Basalt Types will be held at the University of Iceland in Reykjevik, August 15-22, 1982. Basallic magmatism and volcaniem (both oceanic and continental) will be discussed at the meeting, which is cosponsored by the International Associetion of Volcanology and Chemistry of the Earth's Interfor and the International Association of Geochamistry and Cosmochemistry. Emphaels will be on the petrology and geochemistry of the mantle, trace elements, end isotopes. Short lield excursions are planned for before and atter the

Registration end ebstracts of papers to be presented should be received by May 1, 1982.

For additional information and registration forms, write Baealt Meeting, c/o G. E. Sigveldason, Nordic Volcanological Institute, 101 Reykjavik, Iceland. 5

# **Satellite Doppler Positioning**

Tha Third International Symposium on Satellite Dopplar Positioning has been scheduled for Februsry 8-12, 1982, at the Physical Science Laboretory at the New Mexico State Univareity in Las Crucaa. The meeting is cosponsored by the Delense Mepping Agency, the National Ocean

For information about the symposium, write Richard Peal, Defanse Mepping Agancy, Hydrogrephic Topographic Center, 6500 Brooks Lane, N.W., Weshington, DC 20315.

# AGU **Congressional Science Fellowship**

The indivitual selected will spend a year on the staff of a congressional committee or a House or Senate member, activising on a wide range of scientilic issues as they pertain to public policy apestions.

Prospertive applicants should have a broad background In science, be afficulate, literate, flexible, and able to work well with people from diverse professional backgrounds. Prior experience to public policy is not necessary, although such experience and/or a demonstrable interest in applying science to the solution of public problems is de-

The teflowship carries with it a stipend of up to \$25,000 plus travefalluwances.

Interested candidates should submit a fetter of Intent, a curriculum vitae, and three letters of recommendation to AGU. For lurther details, write Member Programs Division, Congressional Fellowship Program, American Geophysical Union, 2000 Florida Avenue, N. W., Washington, D.C. 20009.

Deadline: March 31, 1981,

# International Mare Colloquium

The Jet Propulsion Laboratory and the California Institute ot Technology will host the Third International Colloquium on Mars, in Pasadene, Calit., August 31-September 2. Cosponsora ere NASA, the Lunar and Planetary Institute end the Division of Planetary Sciances of the American Asiro-

Announcements will be sent to ell aclantists known to be ective in pisnelary investigations. Requests for information from others ehould be addressed to Conway W. Snyder, Jet Propulsion Laboratory, Pasadena, CA 91109. Informetion in the colloquium's agenda will be published in July.

The organizing committee includes Arden L. Albee, Raymond E. Arvidson, Joseph M. Boyce, Donald L. Devincenzi, Freser P. Fenale, Ronald Greeley, Garry E. Hunt, Thomas B. McCord, Robert E. Murphy, Roger J. Phillips, Jemee B. Pollack, Conway W. Snyder, and Joseph Ve-

# Rainfail and Runoff Modeling

The International Symposium on Rainfell-Runoti Modeling will be held at Mississippi State University May 18-21. Plannad for discussion are review of present models, directions for future research, and complementary elements of eaemingly different modeling approaches.

Among the topics to be covered are hydrologic deta, stochastic modeling of stream flow, evapotranspiration modeling, linear modeling of watershed runoff, flood routing, walershed sediment yield, modeling in torest and urban sivironmente, end anelysis of hydrologic extremes. Approximetely 200 technical prasentallons are anlicipated.

For edditional information contact Vijey P. Singh, Director, International Symposium on Rainfalf-Runoff Modeling. Department of Civil Engineering, Mississippi State University, P.O. Box Drawer CE, Mississippf State, MS 39762 (lelephone: 601/325-3050). SS

# ASSEMBLY TRAVEL

Third Scientific Assembly, International Association of Meteorology and Atmospheric Physics, August 17-28, 1981, Hamburg, Germany

Fourth Scientific Assembly, International Association of Geomegnetism and Aeronomy, August 3-15, 1981, Edinburgh, Scotland

Universal Trovel Service, Inc., of Woshington, D.C., has been selected as official travel agent for these two ossembles. Contoct Anno Monol, Universal Travel Service, Inc., 1825 Connecticut Avenue, N.W., Woshington, D.C. 20009 (telephone: 202/867-3202) os soon ae possible, indicating your requirements. Every effort will be mode to obtain the best echedule and the lowest oir fares ovoilable, such as super-APEX or group fore.

APEX (odvance purchose excursion fore) must be booked 21 doys in odvance; minimum 7 doys, moximum 180 days; \$50.00 penolly for any change offer licket is issued. A limited number of seats

Group fure: minimum 40 possengers traveling together, may return individually; tickets issued 21 dnys in advance. For those ullending both assemblies, effort will be mode to obtain suitable flights

From home city to New York (JFK) there are special add-on fares and, in some instances, super snyer or published super-APEX fares that can be used in conjunction with transolientic flight. Northwest Airlines has direct service from New York to Glasgow (Prestwick). Pon American has dully sorvich from New York to Hamburg, Northweel, hvice weakly.

If possible, the group fire, which is the lowest fore, will be used to hove 40 possengers traveling over on the same ilate.

#### 1AGA/Edinburgh August 1 JFK/Prestwick NW #38 deport 7:20 PM arrive August 2 8:00 AM NW #39 deport 1:10 orrive some doy 4:50 PM Supar-APEX: \$549.00 Group: \$528.00

# IAMAP/Hamburg

August 15	AAINOUIE	PAA #104			
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		continuity littes	are ovallable		a.

# Travel Grants to IAGA and IAMAP Scientific Assemblies

Deadline for Applications: April 1

AGU has received from the National Science Foundation grants to assist the travel of individual U.S. scientists to the Fourth Scientific Assembly of the International Association of Geomagnetism and Aeronomy, to be held in Edinburgh, Scotland, August 3-15, 1981, and the Third Scientific Assembly of the International Association of Meteorology and Atmospheric Physics, to be held in Hamburg, Germany, August 17–28, 1981 Application forms for the grants are available from

> Member Programs Division American Geophysical Union 2000 Florida Avenue, N.W. Washington, D.C. 20009 (Telephone: 202/462-6903).

# Sedimentology Congrasa Slatad for 1982

The 11th International Congress on Sedimentology, soonsored by the international Aesociation of Sedimentoloels (IAS), is echeduled for August 22-28, 1982, at McMasler University in Hemilton, Onterlo.

Among the topics to be covered et the meeting are Archeen sedimentology, daposition and diaganesis of evaporfles, low-temperature geochemietry, geomorphology of depositional landtorme, environmental aadlmentology, sedimeniology and plate tectonice, daep-see sediments, and

deep buriet diaganesie and majuration of organic mettar. More than 30 lield excursions are planned, and they are listed in the tirst circuler. For additional information about the field irips and the congress, write IAS Congress 1982, Department of Geology, McMester University, Hemilton, Ontario L8S 4M1, Canada, St

#### **Mechanical Behavior of Salt**

A special conference on the Mechanical Behavior of Salt will be held Novembar 9-11 et The Pennsylvania Stete University. The conterence is sponsored by the university's Rock Mechanics Laboratory in the Department of Mineral

Tentative plans ere lo devote a large proportion of the program to the topic of laboretory testing of salt, including a

#### MEETING ANNOUNCEMENT LUNAR AND PLANETARY INSTITUTE TOPICAL CONFERENCE PROCESSES OF PLANETARY RIFTING

December 3-5, 1981 San Francisco Area

CONVENERS: B.H. Beker and P. Morgan SESSIONS PLANNED:

1) Speculetions os to the origin and development of rifts 2) Constraints on rift evolution - setting

3) Constraints on rift evolution - geological development 4) Constraints on rift evolution - physics and chemistry of the

lithosphere
5) Resources associoted with rifting
6) Qur stote of ignorance and its remedy

Attendance will be timited to 60 perticipants. Send applications to attend with brief, but specific outline of potential contributions to the meeting; include a provisional title if you plan to submit an abatract. Abstracts should be submitted to Ritt Meeting, Projects Office, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, Taxas 77058, USA. Deadline for applications is May 29, 1981. Further information may be obtained from ion may be obtained fron the above address, or phone (713) 486-2150.

review of current testing methods and the development of models that describe mechanical behavior. Designing storage caverns and alability monitoring la elso an agenda top-

Cheirmen for the conference are H. Regineld Hardy, Jr., director of the Penn State Rock Mechanics Laboratory, and Michael Lnnger, Bundesenatelt für Geowissenschalten and Rohetoffe, Hennover, West Germany.

For additional information, contact Hardy, Rock Mechanics Leboratory, Room 117 Minerni Sciencee Building, The Pennsylvenia Stafe University, University Park, PA 16802. Participation in the conference is restricted to persons who are ectively involved in the tield. 6

# Geophysical Year

(Boldfece Indicalee meetings eponsored or cosponsored by AGU.)

March 19-20 Tectonics and Ore Deposits Symposium, Tucson, Ariz. Sponsor, Arizona Geological Society. (John Reinbold, Conferencee and Short Courses, Univ. of Arizona, 1717 E. Speedway Blvd., Tucson,

Merch 23-24 Space Science Comes of Ager Parapectives in the History of the Spece Sciances, Washington, D.C. (Rila Bobowski, Public Affaira Officer, Netional Air and Space Museum, Smithsonian inatitution, Washington, DC 20580). March 23-27 International Symposium on Quality of Groundwalar, Noordwijkerhout,

The Netherlanda. Sponeora, Unesco, World Heelth Organization, Commission of European Communitiee, International Aasociation of Hydrogeologiate, IAHS. (ISOG '81 c/o Kivi, P.O. Box 30424, 2500 GK The legue. The Netherlanda.)

March 24-28 Symposium on the Cerro Prielo Geotharmal Field of Baje Calliomia, Mexico, San Franciaco, Calit. Sponsore, U.S. Oepartment of Energy, Commission Federal de Eleciricidad of Mexico, Univ. ol California, Lawrence Berkeley Laboratory. (Wemer Schwarz, Univ. of California, Lawrenca Serkeley Laboratory, Earth Sciencaa Olvision, Barkelay, CA 94720.)

April 5-10 Chepman Conference on Generation of the Oceanic Lithosphora, Airlie House, Warrenton, Va. [Meetings, AGU, 2000 Fiorida Ave., N.W., glon, OC 20009.)

April 6-10 Second iniamational Symposium on Flow: Ite Maasurement and Control in Science and Industry, St. Louie, Mo. ponsors, American Society of Mechanical Engineers, Instrument Society of America, National Bureeu of Slandarda. (Prot. Wiliam Durgin, Aldan Re 30 Shrewsbury St., Holden, MA 01520.) April 8-10 Inlarnational Sympoeium on the Hellenic Arc and Tranch, Athena, Greece. (Prof. S. S. Auguatilitis, International Symposium on the Hellanio Arc and Trench, Netional Technical Univ., Department of

Mineralogy-Peirography-Geology, P.O. Box 1008, Athene, Greece.) April 14-15 National Water Conservation Conference—Publicly Supplied Polable Waler, Denver, Colo. Sponsor, EPA. (National Watar Conservation Conterence, c/o Enviro Control, Inc., P.O. Box 827, Rock-ville, MO 20851.)

April 14-18 1981 Symposium on the Effect

of the knosphere on Radiowave Propagating Systems, Alexandria, Va. Sponeors, Naval Research Laboratory, Air Force Geophysics Laboratory. (F. D. Clarke, NRL Code 418t, 4555 Overlook Ave., Washingon, DC 20375.)

April 28-30 Symposium on Multidisciplinery Studies on Hudson/James Bay, Guelph, Ontario, Canada, Sponsor, Univ. of Guelph, (I. P. Merilni, Department of Land Resource Science, Ontario Agriculture) College, Univ. of Guelph, Guelph, Onterio NIG 2W1 Canade.)

April 30 May 2 10th Annual Flocky Mounlain Groundwater Confarence, Laramie,

Wyo. (Peter Huntoon, Department of Geology, Univ. of Wyoming, Box 3008, Laramle. WY 82071 \

May 4-S Seminar on Non-Sandsione Uranium Oaposiis, Golden, Colo. Sponsors, USGS, U.S. Oepartmeni of Energy, 8endix Field Engineering Corp. (Geology Division, Bendix Field Engineering Corp., P.O. Box 1569, Grand Junction, CO 81502.) May 4-8 13th Internetional Liège

Colloquium on Ocean Hydrodyna mica, Liège, Belgium. Sponsors, IAPSO, Unesco Marine Sciences Division, EGS, Intergovernmental Oceanographic, AGU (Jacques C. J. Nihoul, University of Liège, Mecanique des Fluidea Géophyaiques-Environment, B6- Sart Tilman, B-4000

Liege, Belgium.)
May 6-19 Annual Maeting, Mexican Geophysical Union, Manzanillo, Colima, Mexiphysical Union, Manzanillo, Comite co. (Union Geofisica Mexicana, Comite Reunion 1981, inetituto de Geotlecia, UNAM, Cludad Universitaria, Mexico 20 O.F. Mexico.)

May 10-18 The Structure and Developmeni of the Greenland-Scotland Ridga: New Methode and Concepts, Bressanone Italy. Sponsor, NATO Advanced Research Inelitute. (Svend Saxov, Laboratory of Geophysica, Aarhua Univ., Finlandsgada 8-8, DK-8200 Aarhus N, Oenmark.)

May 11-13 Annual Meeting, Canadian Geophysical Union, Calgary, Alberta, Canada. (P. J. Savage, Pan-Canadian Petrole um Ltd., P.O. Box 2850, Calgary, Alberta, Canada T2P 295.)

May 11-15 1981 Seminar on Tropical Cycione Hydrology Miami, Fia. Sponsora, WMO, NOAA. (Allen F. Flanders, National Weather Sarvice, 8060 13th St., Room

506, Silver Spring, MD 20910.) May 13-20 IUCRM Symposium on Wave Dynamics and Radio Probing of the Ocean Surface, Miami, Fla. Sponsore, NOAA, NASA, ONR. (G. Valenzuala, Physical Ocsanography Branch, Environmental Sciences Division, Code 4344, Naval Reeearch Laboratory, Washington, DC

v 14-15 27th Annual Meting of the Institule on Lake Superior Geology, East Lan-aing, Mich. Sponsor, Michigan State Univ. (F. W. Cambray, Department of Geology, Michigen Blate Univ., East Laneing, Mi

May 18-21 Rapid Excavation and Tunnaling Conference, San Francisco, Calit. Sponsore, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Civil Engineers. (R. M. Orlogio, Aselstant Conference Manager, Society of Mining Engineere, Caller No. D. Littlaton, CO 80123.)

May 18-21 The Internetional Symposium on Reiniell-Runoff Modeling, Misaisaippi Stata, Misa. (V. P. Singh, inter national Symposium on Raintall-Runoff Modeling, Department of Civil Engineering Mississippi State Univ., P.O. Orawer CE, Mississippi State, MS 39762)

May 18-21 Proterozolc Symposium, Madi-May 18-21 Proterozotc symposium, water son, Wie. Sponsor, Department of Geology and Geophysics, Univ. of Wisconsin-Madison, (L. G. Medaria, Jr., Department of Geology and Geophysics, Weeke Hall, Univ. of Wisconsin, Madison, WI 53706.)

or wisconsa, Madison, Wi bay 05-29 | AGU Spring Meeting, Bald-more, Md. (Meetinga, AGU, 2000 Florida Ave., N.W.; Washington, DC 20008.) May 25-28 ! International Tstriami Sympo-

slum 1981, Tsunami Commission of IUGG, Sendat-Otunato, Japen. fE. Kajiura, Earthquake Research Institute, Univ. of Tokyo, Bunkyo-ku, Tokyo 113 Japan.

Oceanographic Society 15th Annual Con-grees, Saskotoon, Saskatchewen, Canade. (8. E. Goodleon, Program Choluman, Atmoepheric Environment Service, 490S Oul-terin Street, Oownevlew, Onterio M3H 5T4 June 1-5 Second Internetional Sym-

poetum on thertial Technology for Surveying end Geodesy, Banff, Canada. Sponsore, AGU, Canadian Institute of Surveying, Univ. of Calgary. (Klaus-Peter Schwarz, ISS Symposium 1981, Division of Surveying Engineering, Univ. of Cal-gary, Calgery, Albeha T2N 1N4 Canada. June 3-4 Sympostum on the Ecology and

Managameni of Reservoira, Université Laval. Ouebec, Canada. Sponsore, Unesco, Université du Quebec, Université Lavat. Hydro-Ouebec, Societé d'Enargie de le Baie James. (P. G. C. Campbell, Univerellé Ouebec, INRS-Eau, C.P. 7500, Ste.

Foy, Quebec G1V 4C7 Canada.) June 4-5 Easiern Snow Conterance, Syrecuee, N.Y. (8. E. Goodlson, Program Chairman, Atmospheric Environment Service, 4805 Dufferin Sireal, Downsview, Ontailo M3H 5T4 Canada. June 7-11 Eighth Ocaan Energy Con-

feranca for the Department of En-ergy, Washington, D.C. Sponaor, Marine Technology Society. (Harry Irwin, Marine Technology Society, 1730 M St., N.W., Washington, DC 20036.)

June 8-10 Internetional Geoecience and Remote Sensing Symposium, Washington D.C. Sponsors, AGU, IEEE Geoscience and Remote Sansing Society (F. T. Ulaby, Remote Sensing Laboratory, Univ. of Kansas Centar for Research, Inc. Wast Campus, Lawrence, KS 86045.) Juna 14-19 Second International Conference on Urban Storm Oralnage, Urbana,

III. Sponsore Univ. of Illinois, International Lialaon in Urban Storm Drainege, internetional Association of Hydraulio Research, International Association of Water Poliution Research, American Society of Civil Engineers. (B. C. Yen, Department of Civil Engineering, Univ. of Illinois, Urbana, IL

June 15-18 International IEEE/APS Symposlum, National Radio Scisnce Mesting, and International IEEE/MTT Symposium Los Angeles, Callt. (Prof. N. G. Alexopoulos, 7732 Boelter Hall, Department of Electrical Sciences, Univ. of Californie, Los Angeles, CA 90024.)

June 23-26 Seventh International Symposlum on the Machine Processing of Remotelly-Sansed Data, Wast Latayette, Ind. Sponsor, Laboratory for Applications of Remote Sensing, Purdue Univ. (D. S. Morrison, Purdue Univ./LARS, 1220 Potter Dr., West Latayette, IN 47906.)

June 24-26 International Symposium on Real-Tima Operation of Hydrosystems Weterloo Ontario, Canada. Sponsor, Waler Resources Group, Univ. of Waterloo. (T. E. Unny or E. A. McBeen, Univ. of Waterloo. terico, Department ot Civil Engineering, Watarloo, Ontario N2L 3G1 Canada.) July 6-11 Geocongress '81-South African Geodynamics Project and 3rd International

Pletinum Symposium, Pretoria, South Afri-

cs. Sponsors, Geological Society of South

Atrica, South African National Committee tor the International Union of Geological Sciencoe, Society of Economic Geologists. (The Symposium Secreteriat S. 217, CSIR, P.O. Box 395, Protoria 0001 Republic of South Africa.)

July 8-10 National Conference on Environmental Engineering, Atlante, Ga Sponsor, Environmental Engineering Division of American Society of Civit Engineers. (F. Michael Saunders, 1881 National Conterence on Environmental Engineenne School of Civil Engineers, Georgia Instituta of Technology, Allanta, GA 30332.)

July 15-17 Summer Computer Simulation

Conference, Washington, D.C. Sponsors, Inetrument Society of America, the Society for Computer Simulation. (William E. Buchanan, Applied Physics Laboratory. Johns Hopkins Road, Laurel, MD 20810.) July 21-23 Chapman Conference on

Spetial Variability in Hydrologic Modeling, Fort Collins, Colo. (Maetinga, AGU, 2000 Ftorida Ave., N.W., Washington, OC 20009.)

July 21-30 21el General Assembly of IA-SPEI, London, Ontario, Canada (A. E. Beck, Department of Geophysics, Univ. of Western Ontario, London, Ontario N6A 5B7 Canade.)

July 27-30 Eighth International Symposlum on Urban Hydrotogy, Hydreuitca, and Sediment Control, Lexington, Ky. (Don J. Wood, Department ot Civil Engineering, 208B Anderson Hall, Univ. of Kentucky, Lexington, KY 40506.)

Aug. 3-15 IAGA Fourth Scientific Assembly, Edinburgh, United Kingdom. (B. R. Leaton, Institute of Geological Sciences, Edinburgh EH9 3LA United Kingdom.)

Aug. 4-7 International Conterence on Energy Education, Providence, RJ. (Donald Kirwan, Conlerence Cheirman, Office of Energy Education, Univ. of Rhode Island,

Kingston, RI 0288t.) Aug. 9–15 Symposium on Variations in the Global Water Budget, Oxford, United Kingdom. Sponeore, ICCL, IAHS, INQUA. (Prof. R. E. Newell, Department of Meleorology, 54-1520, MIT, Cambridge, MA 02139.)

Aug. 10-14 Internstional Conference on Basament Tectonics, Oslo, Norway, Sponsor, Norwegian Petroleum Society. (Roy H. Gabrielsen, Department of Geology, Unfv. of Oslo, P.O. Box 1047, Blindem, Oslo 3 Norway; or Don L. Bears, Department of Geology, Fort Lewis College, Durango, CO S1301.)

Aug. 10-14 Water Forum 'B1: Technical State of the Art Exchange, San Francisco, Calli. Sponsors, American Society of Civit Engineers, Irrigation and Drainage Division, Committee on Dratnage. (P. M. Meyers, 509 North Roosavell Blvd., Apt.

D-105, Falls Church, VA 22044.)
Aug. 10-18 20th General Assembly of the International Union of Radio Science, Washington, D.C. (R. Y. Dow, National Academy of Sciences, 2101 Constitution Ave., Washington, DC 20418.) Aug. 17-28 Third Scientific Assembly of IA-MAP with Extraordinary General Assembly, Hamburg, Federal Republic of Ger-many. (S. Ruttenburg, NGAR, P.O. Box 3000, Bouldar, CO 80307.)

Aug. 17-18 Open Symposium on Mathematical Models of Radio Propagation, Weshington, D.C. Sponsor, URS. (J. R. Wall, Bidg. 20, Electrical Engineering De-

pertment, Univ. of Arizona, Tucson, AZ 85721.1

Aug. 17-22 Ninth International Symposium on Earth Tides, New York, N.Y. Sponsor, Columbie Univ. (J. T. Kuo, Aldridge Laboratory of Applied Geophysica, Henry Krumb School of Mines, Columbia Univ., New York, NY 10027.)

Aug. 18-21 Second Bionnial Conforence end Exhibition of the Austrelian Society of Exploration Geophysiciste, Adeleido, South Austrolla. (J. Halgh, Conference Chelimen, P.O. Box 42, Unley, South Australia 5061.)

Aug. 24-28 International Symposium on Management of Geodetic Oala, Copenhagen, Danmerk. Sponsors, IAG, the Oanleh National Committee of IUGG, Geodaelisk Institut (C. C. Techerning, Internetional Symposium Menagement of Geodetic io, Goodeolisk İnsiltul, Gamleheve Alle 22, Charlotteniund DK-2920 Oenmerk.)

Aug. 24-28 Eighth Annuel Meeting of the European Geophysical Society, Uppsela Sweden. (C.-E. Lund, Cheirmen Local Orsanizing Committee, Institute of Solid Earth Physics, Uppsale University, Box 556, 22 Upppetn, Sweden, L

Aug. 28-Sopi. 8 Arc Volcanism Symposium, Tokyo, Japan, Sponsors, Volcanolo gicel Society of Jepan, IAVCEI. (Dalauke imozuru, IAVECEI Symposium on Arc Volconiom, Earthquake Rasearch Institute Univ. ol Tokyo, Bunkyo-ku, Tokyo 113 Ja-

Aug. 31-Sept. 5 Sympoelum on Geodelic Networks and Computations, Munich, Woot Germeny, Sponsor, IAG. (Deutscho Geodatischo Kommission, Beverischen Akadomin der Wissenschoften, Mnrstallplatz 8, D-8000 Munchen 22.)

Sopi. United Nations Symposium on Weld Menagomont in Industrieitzed Aroes, Liabon, Portugal IChairmen of the Executive Committee, International Symposium on Waler Management In Industrial Areas, Portuguese Water Resources Association, c'o LNEC, Av. do Brasil, 10t, 1799 Lisbon,

Sept. 7-12 Third Intometional Symposium on Antoretic Gleciology, Columbuo, Ohio. Sponsors, Intomational Commission on Snow and ice, injernational Glaciological Society (Institute of Poler Studios, Olile State Univ., 125 S. Oval Mall, Columbus. OH 43210)

Sapt. 13-17 Nnilonal Water Well Associalion 33rd Annual Convention and Groundwater Technology Education Session, Kenses City, Mo. (NWWA, 500 West Wilson Bildse Rd., Worthington, OH 43085.)

Sepi 18-18 Oceans '81, Bosion, Mess. Sponsors, Medine Technology Society, IEEE Council of Oceanic Engineering. (R. Nagle, Publicity Manager, Reytheon Company, 141 Spring St., Lexington, MA

Sept 17-18 Midweat Meeting, Minneapolis, Minn. IMeetings, AGU, 2000 Florida Ave., N W., Weshington, OC 20009.) Sopi 17-18 Pacific Northwest Re-

gional Maeting, Ellensburg, Wash. (Bob Bentley, PNAGU, Central Weshing) ton University, P.O. Box 1000, Depertment of Geology, Eltansburg, WA 98920.) Sept. 20–22 National Weler Well Associ-

ation 34th Annual Convention and Exposi lion, Atlanta, Ge. INWWA, 500 West Wilson Bridge Rd., Worthington, OH 43085.) Ocl. 8-8 International Conference on Time Series Methodo in Hydrosciances, Burlington, Ontario. Sponsors, Netional Weter Recearch institute of the Ceneda Centre for Infand Weters and Walet-Resources Branch of Ontario's Ministry of Environ-

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mani. (A. El-Sheerawi, Aqualic Physics and Systems Division, NWRI, Canada Centre for Inland Welers, P.O. Box 5050, Surlingion, Onlerio L7R 4A6 Canada.)

Oct. 11-15 51st Annuel International Mealing of the Society of Exploration Geophysicists, Los Angelas, Calli. (William L. Beker. Technical Program Cheirmen, c/o Chevron Oil Field Research Co., Box 448, La Hebre. CA 90631.1

Oct. 13-16 Division of Planetary Sciences of the American Astronomical Society Annual Mealing, Pittsburgh, Pe. (8. Hapke, Depl. of Geology end Pienelary Science, 321 Old Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15280.)

Oct. 14-18 Third Surveying and Mapping Colloquium for the Petroleum industry, Banff, Alberte, Canade, Sponsor, Canadi an Petrolaum Association. (Liz Hempton, Cenedian Petroleum Asecciation, 1500. 633 Sixth Ave., S.W., Celgary, Albarta, Cenede T2P 2Y5.)

Oct. 28-30 Symposium on Queternary Land-See Migretion Bridges end Human Occupation of Submarged Coasilinas, Le Jolla, Celif. Sponsors, Quetarnery Shorelinee Commission of the international Union for Queternery Research, Scientific Committee of the World Confederation of Underweter Activities. (Patricle M. Masters. Scripps Institution of Oceanography. A-012, Le Jolle, CA 82093.)

Nov. 2-6 International Conference on the Vonus Experiment, Sen Frencisco Bey Area, Celli, Sponsor, NASA, (Or, Lewrence Colin, Arnes Research Center, Moffell Field, CA 94035.)

Nov. 30-Dec. 11 43rd Sesolon of the Internetional Statistical Institute, Suenos Aires, Argentine, (Jim R. Wellie, IBM, Research Division, Box 218, Yorkjown Heighta, NY 10598; or G. S. Weteon, Bernoulli Society for Methornatical Statistics and Probability, Opportment of Statistice, Princeton Univ., Princeton, NJ 08544.)

Doc. 7-11 AGU Fall Meeting, Sen Fran cisco, Celli. (Meelings, AGU, 2000 Floride Ava., N.W., Weshington, DC 20008.)

Oec. 18-19 Annual International Meeting of the Working Group on Mediarreneen Ophiolites, Florence, Itely. (Lulgi Beccaluva. Isiliulo di Potrogrefia, Vie Gremsci 8, 43100 Parma, Ilaly.)

#### 1982

Feb. 8-12 Third International Geodetic Symposium on Satellite Doppter Positioning, Les Cruces, N. Mex. Sponsors, Delense Mepping Agency, Netlanet Ocean Survey, AGU, (Richerd Pesi, Oelense Mepping Agency, Hydro-grephic Topogrephic Center, 6500 Brooks

Lane, N.W., Washington, OC 20315.) Feb. 16-19 AGU Oceanography Section/ASLO (American Society of Limnologists end Oceanographera) Meating, San Anionio, Tex. (Mealings, AGU, 2000 Florida Ave., N.W., Weshington, DC 20008.)

April 19-21 Cordilleren Section, Geological Society of America and Salamological Soclety of America Annuel Meeting, Anehelm, Celif. (Nell Maloney, Earth Science artment, Californie Stele Univ., Fuller-

ton, CA 82634.) Mey 3-7 14th Internetional Liège Colloquium on Ocean Hydrodyna. mics, Liège, Belgium. Sponsore iAPSO, Unesco Merine Sciencee Olvision, EGS, Intergovammental Oceanographic, AGU.

(Jecques C. J. Nihoul, University of Liège, Mecénique des Fluides Géophysiques-Environment, B8- Sart Tliman, B-4000

May 7-20 General Meeting of IAG, Tokyo, Jepen. (1. Nekegewa, Geophysical Insti-tute, Kyolo Univerelly, Sekyo-ku, Kyolo

Mey 10-15 General Meeting of IAG, Tokyo, Jepan. (M. Loule, IAG, 38 Rue Gey Lueeac. 75005 Perie, Frence.) Mey 24-June 4 Internetional Solar-Terreatrial Physice Symposium, Ottewe, Ontario,

Canede. (Proleesor Uu, University of Illinols, Urbana, IL 81801.) May 24-June 4 24th Plenery Meeling of COSPAR Ottawa, Ontario, Canada. (Dean Kaslal, Space Sciances Boerd, Netlonel Academy of Sciencee, 2101 Constitution Ave., N.W., Washington DC 20418.)

May 31-June 4 AGU Spring Meeting, Philadelphie, Pe. (Meetings, AGU, 2000 Floride Ave., N.W., Weehington, DC 20008.)

June 27-July 2 Fifth Internetional Conferance on Gaochronology, Coemochronology, and legtope Geology, Nikko National Perk, Jepen. (K. Shibale, Geological Survey of Jepan, Higeehi 1-1-3, Yetebe, Iberaki 305 Japan.)

July 18-30 Scientific Meeting of IAHS with Extraordinary General Assembly, Exeter, United Kingdom. (John C. Rodde, Department of the Environment, Weter Oete Unit, Reading Bridge House, Reading RG1 8PS

Aug. 2-13 Joint Oceanographic Assembly, Helliax, Nova Scotle, Cenade. Sponsor, Scientific Committee on Oceenic Reseerch, (Lao O'Quinn, Netional Steering Committee for JOA, c/o Cenedien Comm lee on Oceanography, 240 Sparks St., Ollewe, Onterlo K1A 0E8 Canede.)

Aug. 15-21 Fourth Internetional Sympoelum on Anierctic Eerth Sciencee, Ingle Ferm, South Australia, Australia, Sooneors. Auelrellen Acedemy of Science, Auetiellan Academy of Technological Sciencee, Internetional Union of Geological Sciencee, Scientific Committee on Antarc-Vc Research, Geological Society of Austrelle, Inc., Univ. of Adelaide. (J. B. Jego, South Australian Inetitute of Technology P.O. Box 1, Ingle Ferm, South Austrelie,

Aug. 15-22 injamellonel Mealing on Generellon of Major Beselt Types, Reykjavík, Icaland, Sponsors, IAVCEI, IAGC, (Basalt Meeting, c/o G. E. Sigveldsson, Nordic Volcenological Inetitute, 101 Revkievik.

(celand.) Aug. 15-22 IAVCEI and IAGC Joini Meei-Ing, Reykjevik, Iceland. (G. E. Sigvaldason. Nordic Volcanological Inelliute, Univ. ol Iceland, Geosciances Building, 101 Revkievik, (celend.)

Aug. 22-28 11th International Congress on Sedimentology, Hemilton, Onterio, Cen-ada. Sponsor, IAS. (IAS Congress 1982, Department of Geology, McMeater Universily, Hemilton, Onterio LSS 4M1, Canade.) g. 23-27 Ninth Annuel Meeting of the European Geophysical Society, Leeds, United Kingdom. (C. R. Argent, EGS Secretery, The Royal Society, 8 Ceriton House

Terrece, London SWIY, 5AG, England.) Sept. Third Internetional Kimberilia Conter ence, Clermont-Ferrend, Frence. (Frencolee Boudlar, Université de Nentee, Laboretotre de Teclonophyelque, 2 Rue de le Houselniere, 44072 Nenteo, Frence.)

May or Sept. Scientilic Meeting of IAPSO, Halliax, Cenede. (E. C. LaFond, LaFond

Oceanic Coneuliente, P.O. Box 7325, San Olego, CA 82017.)

Oec. 8-10 AQU Fall Meeting, Sen Francleco, Calli. (Meetinge, AGU, 2000 Florida Ave., N.W., Weehington, OC 20008.)

#### 1983

July 18-23 Fourth International Conference on Permefroet, Feirbenke, Aleeka, Sponsore, Netional Academy of Sciences, Bisla of Alaske. (L. De Gose, Poler Recearch Board, Netional Academy of Sciences, 2101 Constitution Ave., N.W., Weshington. DC 20418.)

Aug. 15-26 18th General Assembly of IUGG, Hemburg, Federal Republic of Germany. (P. Melchlor, Observatoire Royal de Belgique, Avenue Circulaire 3, B-1180 Bruxelles, Belgium.)

Aug. 27 Sympoelum Commemoreting the 100th Anniversery of the Mount Kreketeu Eruption, Jekarta, Indonesia. Sponeor, Indonesien Inetitute of Sciences. (Didin Sestrapradje, Deputy Cheirmen for Netural Sciencee, L1P1 JL, Teuku Chik Olliro 43, ekarta, Indoneele.)

Sept. 12-14 National Water Well Associetion 35th Annuel Convention and Exposition, St. Louis, Mo. (NWWA, 500 West Wileon Bridge Rd., Worthington, OH 43085.) Dec. 5-9 AQU Fall Meeting, Sen Frencieco, Celif. (Meelinge, AGU, 2000 Florida Ave., N.W., Weehington, DC 20008.)

# FUTURE AQU MEETINGS

Fall Meetings Oecember 7-11, 1861, Sen Francisco Oecember 8-10, 1862, San Frendsco Oecember 5-9, 1883, Sen Frencisco

Spring Meetings Mey 25-28, 1981, Bellimore May 31-June 4, 1882, Philedelphie

AAPG American Association of Patroleum

AMS American Meteorological Society ASCE American Society of Chemical Engi-

**GSA Geological Society of America** IAG International Association of Geodesy IAGA Internetional Association of Geomag neliem and Aeronomy IAHS International Association for Hydrologic

cal Sciences IAMAP Internetional Association of Melecrof ogy and Atmospheric Physics IAPSO International Association of Physical

Sciences of the Ocean IASPEI international Association of Salamoiogy and Physics of the Earth's Interior IAVCEI International Ageociation of Voicerology and Chemistry of the Earth's Inlattor IUGS International Union of Geological Sci-

IWRA Internetional Water Resources Associ-

MSA Mineralogical Society of America SEG Society of Exploration Geophysiciete SEPM Society of Economic Peleontologists end Minerelogiats

URSI International Union of Redio Science

# Meteorology

JI20 CIIDOSOLOGY LONG-TERM MEARE AND SHORT-TERM VARIABILITY OF THE OFFRECE EMERGY BALANCE COMPONENTS AT THE SOUTE

Requeece, Bulverslay of California, Davis Ca 18616, U.S.A.] and S. W. Fitch.

Based on a marry cootingous data set obtained between April 1875 and Datesbur 1977, a summing of suassessi seems of the directly assaured and returnable anarry fluxes and easage see the floor-serm (delly) variability in these croposents in response to changing synoptic conditions are presented. The massocially averaged observations are consistent with those of previous studies, indicating that thoughout ment of the year and radialive lose from the surfect occurs averaging in to 13 m par year. In summer, the domated fine of heat from the air [hs] extends the satisfication losses by 10 to 20%, resulting lateral studies of heat in the deep socopers. In visits the radiative loses average between 16 and 20 km 2 with Re supplying \$5 to \$0% of this lose and the

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sun and pienetary waves up to zonal wave sumber three. Proquent significant responses of verious harmonic components in a broad range of oscillation lesquesties give evidence that solor esticity plays a significant role for the dynamics of the middle and lowes stratesphere. Oscillotions of the sonal bermonics which ore coherent with solar stratesphere. servonce when note convert which sold scriptly fluctuations were extracted fact the spectra and recomposed into otherent planatory; where Three wows with periods of 25 days (near to the sea's reintless period); 13.5 d (first tarmonic of noise rotation), and 15.1 tarroole of nolar rotation), and 15.1 days icorresponding to the well-known 15 - 16-day wave in the atmosphere are carried in datell. They show the properties of free planetary modes (13.6 d as 15.1 d) and possibly of internal waves 128 d) or higher follandow. Voctifiation cycles of the ocean etmospheric test tincluding stationary waves seem to be leportent for the generation of the studied wave phonomene.

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INCLES IN AIMOSPIRAL MODELS
JAN B. Roads [Scrippe Inalliation of Ocennography .
It halfs alliamie 92091]
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# Mineralogy, Petrology,

4160 MELT SEGRECATION FROM FARTIALLY MOLTEN SOURCE REGIONS! THE THYONTASCE OF MELT DEPOSITY AND SOURCE PEGION SIZE

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Calcach, Paeadena, Ch. 91223) D. Waltst, E.H.
Rager and J.F. Hays
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is about an order of segmitude higher shan thei
of mantis nimerals. Consequently, the density
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The increasing joilvine-normative chracter of
primary maint produced at greater depths is also
expected to secult is a decrease in the dessity
sources with increasing source segion depth.

Increasing in persential for a secular secular
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Region size influences these lights errongly: consequently, easily, partfally solten dispiral (-ks is dispetur) soy he shis to true large emit fractions (230%), but larges source regions would be usable to do so. The reduction in density contrast with pressure reducts the buoyean force diving meli perceition and provides souther limit to meli perceition and provides another limit to meli perceition and provides another limit to meli perceition and pair at adapth cay thus stably contain large leactions of any though the stably contain large leactions of any the may derepasse and unload their mait during ascent; this effect would be enhanced is small dispire and may be relevant to the general during ascent; this effect would be enhanced in a factor in explaining why the very different mail due depths infertal for typical bests mell aspectation from source segians on different plants — 500 km on the moon, -210 km on Harm, -100 km on harth — torramyond to minitar pressures; 125-13 kett] at greater pressures, and may no longer be sepable under ordinary canditions of segrenting upwatch by becomes. This may also help to explain why deplaced perfocites and sowelle more fertile periodician and how deep regions of the mantle are able to tensiu desp regions of the martle see able to tensis fertile over geologic time. (dispire, igneous petrology, konstifres, unit ulgration) 1. Seconds 2, Prin, Red, Paine 189238

4250 Paragenasia, sairography and potrogenests BASEMENT PFILLING IN THE WESTERN AYLANTIC OCEAN: . MAJONA FRACTIONATION AND 115 RELATION TO EMPITIVE CHECKULOCY

EMUTIVE CHRONICAT H. F. J. Flower Hopt, of Gool, Sci., Univ. of Hillsois, Chicago, LL. 80890; P. S. Poblimon Petrologic/smachusical studies of basels drilled in Cretacuous ocuanis cums; 1850 Logs drilled in Cretanous counts caus; fixel Loga 51-53 in the wearest Atlantic double are againessed in quantifative models of tages itserioustic mechanisms. From lumit-squares are alwis of whote-rock, glass and theorems principle compositions in its concluded that fractionation by greatilization of olivious, playinclass and climopressure involved gravitative separation of tartic phases into playinclass. Floration of ningloclass organisms after with dissipation tension of principal degree suggest creatilization begon alweitly after generation of principle liquids in the sample. Polyburit tractionities and mixing or derivative suggest desired to the located by evidence for solid-liquid sourtion and low-prosoure energed libration. Implies 'series' probate energuilibrath n. Truptive Berles Lounded by megnotic and other statigraphis discentifulties correspond to chalicalivedeline agest tractionaries settles. The latter probably derive from Jistinor parental magna batchae defive two into interest maps satematically all injurished from one mother chrough small differences in degree of postial maintage. Lithophile slowest where not self-sets becomes and the crustal construction at the Atlantic tides and crustal construction at the Atlantic tides and arrangement of maps around the shadows and appears and home extending shadows and the same all none extending shadows the destruction of the same all none extending shadows are all sate that the same all none extending shadows are sate that in the same all none extending shadows are sate that in the same all none extending shadows are sate that in the same all none extending shadows are sate of the same all sates as the same all sates and sates are sates as the same all sates are sates as the same are sates as the same are sates as the same all sates are sates as the same are avoises for emptive units relieve the sep-sonts of post-emptive phonetyes redistrib-and syn-sruptive chasges in liquid fraction suppositions. (megas, incolonation, petun-gassis, ocean crust, laws) J. Geophys. Ros., Pad. (Mpst 10026)

# Oceanography

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E.H. Schumenn infational Sesserch Institute
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the circulation symmics, however the silect of
supplying the cost of the Apulhas Currant also serve to produce maskedly
differing tegiese. Thus in the northern region
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signals propagating fato the regions produce a
dillout form or raspects. The measurements are
not comprehensive smooth to allow non detailed
investigations as to the nature of these signals.
ICostinents shelf, carrents, temperature, wind
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southnest someons or Gulf Strees adding beving
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4728 Estuation, Boys and Flords OBSERVATIONS OF SURFACE AND BOTTOM ORIFIES MOVEMENTS IN THE BEAUTORY SEA MEAN PRUCEQUE BAY, ALASKA

OSSERVATIONS OF SURVACE AND BUTTON PROCESSE HAY ALASKA

J. B. Meithers, [Geophylical Initiate.
University of Alaska, Eirbenks, Alaska 99701)
Surface defitors have been released in the Benufori Sea neit Prudina Bry for Enes consequive years. Not releases texts usde nither this shorefast lee had oroten up and one release was rade year preventing whole-free currents during the coveries suggest that the sovements result recoveries suggest that the sovements result currents under the ice in winter which probably contribute to the observed novements. Orifiers released just before a large storm of the contribution of the contribution of the contribution of the contribution of the sease of the sease of the winter which has received and companied passed are consistent, with the values of 35 or the wind tropagort there the values of 35 or the sind tropagort there has been paried. The reliation of definition in forth Apprica despite are very the recoveries are companied to those for containing passed in forth Apprica despite are very the reliation of the reliation of definition in forth Apprica despite are very the reliation of the sind tropagort the strength of the recoveries are released. There were a contained to the shortheards movement were for definition of the recoveries are released. There were the reliation of the recoveries are released to the season of the sind of the such and the season of the season of the sind of the season of the

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waggraphy, University of Sydney, 2006, fl.s.m., waggraphy, University of Sydney, 2006, fl.s.m., Ameratical Samu empirical formulae for the size and shipe of sand rippies and derived from an enalysis of the ester and satisant retires even a nippied bed in eacilitatory flow. Simple physical arguments show that rippis eleganess should be a tencime of the mon discussional shear attents. All available data seem to support this. The rechamism that determine the rippis length are very complex, and as least tour non directional parameters are important. However, to practical purposes the rippis length is sell determined be the mobility number?. Vis consentially the section of the water valued ty applicate to the sediment settling valued by the rippis length and rippis helphs are shown to depend mainly on the first and and natural ways carlots are completed. The derived Journales apply where ripping occur. Ingural ripping crey opensality the same rules as laborated; ripping, however, they are generally shorter and flaster due to the irregularity of natural sames. Secretary Res., Green, Paper 11 (1950)

SA ICE. WISTER CONFECTION AND AND INSTRUPERAYUPE HISTORY LAYER IN THE SOUTHERN OCEAN John N. Loole fractile Marine Environmental Laboratory, JHI 18th Ann. M., Scattle, Ma 981051. The structure of the next burface waters in the Southern dean, polesarid of the Anternic Folar Yront, is inventigated with a fixee differentiability in the dependent neutrinal co-led which resolves the annual sea ice evels. The growth and decay of the text field to predicted, wells not of Southern's (1974) the troodynamic for to-delay in terms of specified attempheric data and computed thereshaline characteristics of the new inlayers. The left listed to lowed to be sensitive to the lateral advection of they by the negative to the lateral advection of they by the negative data to deep winter investigate the temperature tablisms invertible beautiful to the temperature ability of the model that the substitute of the temperature ability is not in the fewithern than as the remain of a deep white citied there affiliate in notice. The predicted there affiliate lateratorial in all the temperature affilms later and the surface sized liper the burst of the data fortuit of the temperature affiliated attacked in a predicted the predicted the annual all standards of the auriate sized liper the burst of the data predicted the predicted the transportation of the temperature and the desired to the predicted that the annual all seasons a situation of the lateratory of the lateratory of the lateratory of the lateratory of the product of the covern acute of the Annual all trades of the An wouth of the Atlantic Colut Front in much wriller

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Pary C.B.D. Thompson and T.J. Colding (ES18)
Division of fishbories and Geomography, P.G.
Box 21, frontile, NSW 2210, Australia)
The Frent Barrier Peof is simbler to some

The Frest Barrier Peof is similar to some other coral reofs in growing sight up to the odge of the shelf is a region of nutrient-poor surface water, but large tides. It is suggested that the coulding strong tidal currents such in nutrient-rich waser from the nearby deep water. The multionis could encourage the reof to grow vigorously at the edge of the shelf. Note observations in Cook's Passage (14 32 % 15 % 15 % 15 was made to test the concept and arr encouraging (itles suches, reel nutrients, upwelling) J. Geophys. Ret., Green, Paper 100357

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Ryabchenko V. A., Safrat A. S., Turrkov V. G. The [1 All-Union meeting on mallies simulation of the occanic and atmosphinic circulation (2—1) April, 1978, Valid.

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J. J. Carroll |Department of Land, Atr and Water

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174 Billitt Effect of Drift-Lere
ELECTOOMAGNETIC WAVES IN TWO
1841E-1350MAL MAGNETIC FIELDS S. Might of the Physical Department, University of Denier, Denier, Colored 602031, V.L. Patel A (ac temperent that and hold) magnetoghate greene, with spatially variing densuites and temperatures, is considered for the case where the equilibrium magnelle held to the case where the equilibrium magnelle held to tue-dimensional A size getween yout her the eliess of field line A sixt get weity intities the effect of field line ter sing, in first order. A linear theory of low frequence, long wavelergib, electromagnello moder is described. The mides are delices unstable by the egalist gradients in density, remperables, and Refield. The electrons of the cold component Getermine the polarization is the Gold component Getermine the polarization of the wave life to meritation pitted. A fluid-like metability of the drift-compressional mide is found to occur. We limb the critical value of the lief curveture scale larget, helds which this mide is subta. Analytic experience in the comprise of the lief. exploration to the eigenfrequency and eigenments are given. The perforbed fields are found to de accomply trained in the coded direction. Tombie Ben , Blick, Paper 180212

(Ith Reason translation
THE RELATIONSHIP OF PEELD-ALIGNED CURRENTS
TO BLECTROSTATIC ION CYCLOTRON WAYER
Cynthle Causell (Space Sciences Lebocator), thenesely of California, Breitsely, Californ 6 Willia
Two sources of free assergs for driving too cyclotron assess have been observed on the S3-3 satultin - field-aligned current and lon bearts. Since the waves are destablisted by the thermal electron defile and not the current, before conteining observations of field-aligned current with ion cyclotron waves, it is first accessary to determine that the cayestern waves, it is first accessary to determine that the careful to primarily carried by themsal electronact Confessions of the targent carried by energic particles with the teacents and the secondary the case Satistical studies bridges that the field-aligned current dentity is continued with the specified dentity during low cyclotron avenue. The combination of the results of this report and those of Knitow at al. 1979 is consistent with the hypothesis that the observed hose cyclotrop were as any drive by a combination of ion beams and about on drift. However, the available data set does not sample quality identity the free carry source.

J. Geophys. Pas., Sian. Paper 140181

Singly Audators).

Gnophyt. Pro. Lett., Paper 110171

3715 fiapped particles
CNGN/SIVING of And-Harmal 10NS in THE JOVIAN
AMANDI/SHIERA
D.C. Marilton Department of Hiverite and Satronova, Kolveneity of Maryland, Colinge Part.
Harviani, 20713) G. Chorrier, S. K. Frieigle
and I. J. tansarott

We present cheeveations from Vorager i and 2 of
non-thermal ions from K through Vs in the Javies
reantcaphers union the low Santay Particle Inferacrys Hispit, one of the two sensots of the Low
foragy Charged Particle LiEff; superitoria. A. V.
Maylout, the sajur constituents of the low of
foragy Charged Particle LiEff; superitoria. A. V.
Maylout, the sajur constituents of the low oppulation were R. He. C. O. Se. 3 and the hydrogen
solicules at and Er. Velative to Ma. the shursdance of A and H at stud energy/nucleon was
highest in the outer trageologishers, the abundance
of O. Ma. and 5 was highest in the inner regnolosphere, and the shurdance of C was constant
throughout the Enganteybere. He and C may be
of lorgely and order orders. The variations in
studence statics was sectoraparial by a general
lardering of the energetic particle spectre many
I McV/ove with decreaming radial distance. We are
able to ffind a paterettr, resumed to be a
species-dependent constant times cnergy/nucleon,
in terms of which the flux ratios ason cost
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cor all higher. The lathe ratio changes at a
core, with the Abundance of H ions being a factor
of all higher. The lathe ratio changes at
come ratic for N. Ha. C. O. and S. If Re
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by invariant suprementation of the

# izvestiya Physics of the Solid Earth Volume 15 Number 3, 1979

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turbing of the houndary conditions.

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MELYER Berdichersky M. N. KAPO Geophysical Monograph sGeoelectrical and geothormal

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5775 Trapped Periicias
ion CoMpostron of ZIPPER EVENTS
S. M. Kaye (Lockhed Pain Alfo Research Laborainry, Peln Alin, CA 94304), E. 6. Shellay, R. 9.
Sharp and R. G. Johnson
A class of fon distributions has retently been
identitiad by Fannell at al (1920). The distributions are composed of two components, a lenmanary component with peak tiwes directed along
the field tinn, and a high searcy component with
poak fluess in the perpendicular direction. The
frame fluess in the perpendicular direction.
Secases of the appearance of fini distribution on
as energy vs. thus apectrogram, the fon event,
have been called sippers. The purpose of this
report is to Examine the mess composition of the
aloper search. He find that the low energy and
parallel component is composed primarily of 0°,
with in a lesser degree H° and a Leace of He².
The high energy and perpendicular component is
predominently H°, with the relation abandency
of 9 and Ne² form from thour of the less energy
topponent by a tation of 1.3. Those rounts
suggest these whereas the low onergy component is
probably ignosipheric in origis, the scatte of
the high energy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none from the search of the high anergy component is none f

J. Goophys. Ros., Slue, Yapar A10143

S780 Wave propagation
TWE LEFECT OF MOD NAMES ON THE THRESHOLD WAVE
fills FOR INITIATING VIF MON-1 HEAR GROWTH
AND EMISSIONS
Richard L. Dowden (Department of Physica,
University of Otago, Dunedin, Hear Zaeland)
Wif non-1 thear wave growth can only be
initiated by signals above eone themshold
amplitude. Cerrent Theories of noil prodiel this lor a uniform or smoothly verying
geomegneile field. It is shown here that
if near-roadment electrons Ess flactuations
in the total field of sefficient frequency
and amplitude, cyclotron wave Trapping and
thus non-tinear growth cannol occur. HOH
waves in the VIF interaction region have
sufficient amplitude (>2-1) on race occasions
to close the threshold above VIF growth
seiseration lovel while MUS background lessia
of around .65; weeld produce a base layer
threshold only a little below an estimate
nade from a VIF Event and described hero.
J. Seophye. Rea., Eles, Paper 140005

Misternance and terhalque
Mister-Mode dignals: SpectroGraphic Group
Dilait

5. Thornon [Physics Aspattonet, University of
Stage, Dumedin, Saw Zasiand]

Vil Boppier (tequency shifts and group delays
for ledividue; whister ducts can now be
separated and displayed in a switt-dure, environsvet. These cassutements of the shutlaneous
sections of the individual durts show that there
is quite commonly a significant and readily
measurable species variation in the salcurabet
sisteric field in the sagnotcosphera. The
superimental technique, which involves an
improvement of the previously reported tromputer
cross-correlation method, size tilows the use of
ESF coded VLY transmissions as will as allowing
the whistior-mode signals to be received from
any direction without a until in the direction of
the subhomospheric signal as before. (Whistiorgody, sisteric field, duct delici.
J. Googhys. Ras., Slas, Papor 140075

# **Physical Properties of** Rocks

Olio Siatticliv, (recture, and (low like DEPENDENT VSICTION OF GRANIFS: IMPLICA-VIONS FOR PRECURSORT SLIP ON VALUES V. Johnson (lazont-boherty Gootogical Ubsar-vatory, Columbia Solversity, Pallsades, Few York 1996a)

y. Johnson (lacont-boherty Geotogical Ubsarvatory, Columbia Solveraity, Pallandes,
Few York 1998A)

Inicitanal forces were assured during sliding
botween sew-cut cylinders of Barra granits deformed in a serve-cootrolied irlevial leading
grachine. Two different affects ortcut, depending
on the type of loading. When aready shortening
on is etably sliding sample is hatted endemly,
silp rosationes at a diominishing reas, which
depends on the ingarithm of the inirial alfding
valocity. Than, the frictional fetength of the
surface is degrossing with time. When shortening
at a consist rate resumes after the holding perid, however, the frictional resistance responserily rises to a peak proportional to the logarithm
of time of no driving, showing a sani-heaven incrases in friction with time. The sobsequent
decrease in resistance from this peak is continuqua. The observed frictional realizance of a suverat
force thus results from the interaction of saverat
processes and is not a roomtent, is general, but
depends on the incading and preceding deformation.
When shortening is resumed after a period of holding, stip rate across the friction surface tempotarily seconderates above the driving rate. The
attp rate can thee allbar decrease to the driving
rate and remain slable or accelerate further and
isad to elich-slip molion, at arross levels below
the peak value. There is no apparent difference
in the frictional temistances, until the unhoading
rate of the issuing sactine is exceeded below
the peak value. There is no apparent difference
in the frictional temistance, until the unhoading
rate of the issuing sactine is exceeded below
the peak value. There is no apparent difference
in the frictional temistance, until the unhoading rate of
the loading machine. The suidence that accularating slip util occur before serrheashes. Diffortuncted in a tief with the well-and pot in der calcin. Reverthelegar, a clausible mechanica
for gancreling observation, experimanal indicate that slip aned not be oclayed that is accu

various. J. Ocophys. Set., Red. Paper 180141 olfo fqualitime of alset Michael Carlotte Christole (Nicola Christole) and Massachurts of Single-Crystal Mostfells in The Pressure Range is 95 Grave Y. Symno (The Research Institute for tron, Steet and Other Metale, Toboku University, Sandel 980, Japusi, T. Gota, J. Seto end II. Takel Shocf compression superisants have been perfice (Mg.5004) in the pressure range the 3 GPs, using a newly inclusied for—single crysts fortal rice (Mg.5004) in the pressure range the 3 GPs, using a newly inclusied for—single fraction of the values of the vary with the shock propagation divertions with respect to the crystallographic uricettation, reflexing a noteble seasite asion-tropy in the cityles crystal. The targest value of Mil up to 12 GPs is observed in the shock of Lacation polisist to [040], to the hydrostatia regime, thech date to the shock are divided into two particle velocity (Up) pieho are divided into two particle of particle velocity (Up) pieho are divided into two particles of GPs, a famer ill with the squallon Up = 0.4 have indicating a pheso trasmition. For the shock date of the surface of the sound of Japan and a 1-12. There were only to pressure of the sound as 1-12 represents with the utilization. Havingham of vice particle in the contraspondents of the present and fall to the observation of shock restands afformed to strained to anterespond to the outsel of the puse crange.

J. George of the present and approach of the particle of the particle of the present anteresting. I (Shoch temprise form, Fortieriis, high pressure, phaga transferon. Planetology

6570 Surface (first ba) of moon (machanica) properties, topography, albado, atc.t HIGH RESOLUTION ALBEGO NEASUREMENTS OF TO FROM

properties, topography, albade, otc.:
HIGH RESOLPTON ALBEON MEASUREMENTS OF 10 FEDN
VOYAGE 1
5. Todd Clarcy (California Institute of Tachnology, Pasedeas, CA 9115) and G. Edward Danishom
The photoentric proporties of the autiaco of fa
were investigated at high aportat resolution by
a thoice of 226 sempla regions from the lowcolor, 8 fm/fp resolution photoenomic of to taken
by Voyager 1. The mosact longitudinal coverage
autends iron ~208°M to 150°M (phane magin ~10.5°).
The regions were categorised on the heals of their
visual color in the color princ. Calegories
includes white, yellow, prenge, rad, brown
(polar), and black regions.
The photometricolly corrected data were plotted
as a function of intensity wereus photometric
onglas for each of the color regions in sell four
filters (orange, blue, violer, My) using a
Hennant function. The plots of these tellor
tegions show loogs center chout the losst equates
fitted lines. The large seator, particularly for
the darfer regions, indicates a continuous distribution of sibedee on in one given evidence of
toaponitions indiag, in all eenes, lich darfening coefficients with annual error bounds (e.g.,
error <0.2) are found only for the white (k =
8.6 i 0.1) and brown (h = 8.6 t 0.1) regions.

The larger coefficient Cound for the brown regions
is bianed upwards due to poler derkealing. Computnd values of the limb derkening do not theogs
significantly smong liters.

Cotor vetto plots of the reflectances for each
of the regions were consendation.

Cotor vatio plate of the reflectances for each of the regions were constructed (UV blue and violat/blan various orenge/blue). The distributions of ratios of the regions color region era compared to laboratory measurements of solid \$0. [Nosh at al., 1980] and various oblictropes of sulfur (from J. Veveria and J. Gralt, Carnail). These comparisons indicate in is the major component (photometrically) of the "white" regions. Red and white sulfur ore serve se variable components of these regions. Color cattes of "brown" tagions suggest a pixture of white and ved sulfur. A significant portion of the "brown" regions engineer those of pure white sulfur. A component of \$0. ft tound for all "brown" regions and appears to be latitude dependent. Red regions appear well described by a misture of tod and ormage sulfur. J. Goophyn. Res., Red., Esper 180118

5580 Tohelles BIHI RISHED TEXTITE ASLATION IN THE WARF BY A

SMARN

F. Sepri Larco Systems Division, 18; Lausi St., Unimington, Mass.) K. K. Chan and J. A. O'teefs Among apeciana of any telice strown feld, auriace ablation murhings indicate that a large variation occurred to the asradynamic heating of these specimum. It season incomporable these some tektices lashibiting ring wave melt ilow) must rektites lashibiting ring wave mait ilou) must have antered the atmosphere at greater than eccape velority, whereas others fexhibiting sherp surface featured at each lower vetoctiles. A reconciliation it proposed in the form of a wohe shfeiding model, from which it is concluded that tohtites trailing for which it is concluded that tohtites trailing for the ways of a sware experienced diminished heating. Calculations Indiests that waste takitee may have entered at greater than escape velocity while barely reaching must important at the certace. (Isktites, abistion, serodynamic heating, wahe, strophartic entry, smare matlest.)

J. Goophys. Res., Red. Power 180206

# Seismology

6920 Emplosion asismology CONSTRAINTS ON CRUSTAL STRUCTURE IN CASEERN ICELAND BASES ON EXTREMAL INVERSIONS OF SEISMIC REFRACTION

ASSES OF EXTREMAL INVERSIONS AS SEISMIC REFEACTION
DATA
K. MacKerie (Scripps institution of Oceanography,
h-015, University of California at San Siego.
Is Joins, CA 92930) J. McClein and J. Groutt
In the summer of 1978 the incland Research
Drilling Project undertook the drilling at a deep
trustal hole near Reyderljorder in eastern icoland,
As a parl of this project, the Scripps iositicfion
af Oceanography and the University of Maskington
undertook a mall stale ablant refraction expertmant near the drillisto is an altempt to compare
surface geophysical measurements alth observations
of ammies from, ead togging in the hole. Using
recast edvance in the methods of extremal layereige of astumic date, we have determined as approximage ano-dimentioned velocity structure for the
drillista. This structure trustcates that the 1.9
im hole failed to penetaste the layor 2-layer 3
tremation which was at some 3.0-4.5m beneath the
drillisto. The transition eppears to be rather
though, and the homeath the ocean, atth velocity increasing from 5.2-5.5m/asc to the upper
treat to about 6.7km/coc in layer 3. We observe o
steep eactward dip and a shallow westward dip in
the lower crust tway from the nearby Thingolit and
Rayderfjorder roleante centera, respectively, in
eprement with previous work ossociating shallow
depths to layer I with Taretary volcanic teniars
es a receit of increasing metamorphic grade and
increased dyke awarm intensity. (Smissic cofraction, Iceland, trweston, trustal attuature).
J. Geophys. Ras., Red. Paper 120109 cophys. Rus., Red. Paper 180109

6950 Saismic morrows (machanisms, magnitude, fraquency spactrom, space sed tips distri) FRICARONS TO THE KALAFANA N=7.2 EARTHQUAIN Has Myas (Cleas, informatic of Colorado, Boulder, CD 883DP) P.W. Elsin and A.G. lobusco The Kalapana, Result sattlemaks of Noromber 1975 had a rupture length of 48 to 50 km and was located on the south flank of the active voiceno Lifensa. The south suchanism sor dip-slip normal fauting on a place dipping 28° to the 88, with the greatest primitpel stress or served on, with the greatest principal strees of lest fin that dirontion and accumplint by volunto intresions into Silausa's rites. The source eras of the 1975 earthquaks was subject to intensian geological and gamphysical research for any your before this arthquaks because of its proximity to the vaforance. He studied here is operation for 4 to 10 years bafors the sainshook and seedeth trianguictions and trilaterations in the source area had has cattind out repostedly since 1914. We found that pracuracyy changes occurred chroughout most of the sapures area, but in two distinctly different patients. In the imager ones morealous area the sainsicity vers was accreased by 10% during the 1.8 years believe the sainshook; in addition saveral geodetic lines indicated anomalous strain relowes during this time. Within two inner areas the sainsicity remained high, then increased aboutly hefore the sainshook. Is our of the inner state a P-ways travel time delay of 0.2 see could be descend, which hegan shout 1.5 years before the mangehook. Within the of the inner wrote a P-ways travel time delay of 0.2 see could be detected, which heps about 1.5 years before the mainshook. Within the other inner secusalisting until the free helf of 1975 when 1.5-10-4 stwell (35 here), and released are inside the property of the property of the first property in the firs

6950 Seissio sources
PECUSSORI SEMPE OF SPECTRAL CERRACTERISTICS
PECUSSORI SEMPE OF SPECTRAL CERRACTERISTICS
APPORT DE 1976 MINISTER-OUT ERRYNOMER
L Salto (Geophysical Institute, Faculty of
Science, Toboks iniversity, Sendel 980, Jupen) and
A modernic extriquake (Jun. 3, 1977, M=5.8)
Minyaci practicute, northeastern part of Japan, and
an obrious change of select extinct of Japan, and
an obrious change of Select extriputes (M=1.5)
A modernic modernic extension of the main shock
tells arbit the focal region of the main shock
and its vicinity. The change of selection activity
and its vicinity. The change of selection activity
and its vicinity. The change of selection activity
and its vicinity. The change of variation. In
this paper, the apportant characteristics of about
130 axili surchquake previous to the nain snoch
130 axili surchquake previous to the nain snoch
130 axili surchquake previous to the nain snoch
result shows a distinction difference of the
relation between the actual commont and mrems
drep for the two partods. In the forcer period,
yourne dissession is consider and mental on the
average dissession is consider and mental on the
average within in the latter period, it is not
constant but (acreases with thereaseing selection
there as slight improve has been readily folioused
by a creater reprune, and at lest the energy
relates us the onin shock has taken piece on the
whole area of a fault. (Selection const. elves
drep, source dirension).
Fel. Fap. Tobolu Bully, Ser. 5 (Tobelva Geophys.)
Journel Tol. 2t, No. 3-h, 1950

esto Selenic sources
CRUND MOTION IN THE SEAR-PISID OF A PLUID-ORIVEN
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CRUND MOTION IN THE SEAR-PISID OF A PLUID-ORIVEN
CRUCK AND IN INTERPELATION IN THE SEARY
SALION VALENIC THEMS
8. Choose (Depriment of Larth & Pimpilary
Schotter, Nathernhametts institute of Tachnology,
Cabridgs, Nats. U.S.A.)
Ya present a study of a limit-driven lonello cruck
chedded in a layered hall-space. The source that
we resider is the jerky opening of a channel
conserting two limid-filled crucks, and the cause
of this spaning larths success pressure of find
none at the create. We aske a compilate representation at the three components of ground
rottes is the space, thee, and traquency domains
and arsiyas the effects of finds compressibility,
neared depth and median attracture on the ground
response. The calculations show the presence of
a declarant frequency of motion thich depends nor
only on the course geometry and bulk modulus of
the finid, but also on medium characteristics,
receiver position, and the component of motion
takes considered. Wring this source model, we
wise an epicade oil volcenic tronce as a contirow sequence produced by numberous jetty openings
of channels occurring randomly in the along a
chine of create. Our results are applied to the
Crober 5-b, 1961 enat rife eruption of Vitauea
welcaso, Ravoli, and found to be compatible with
smallable selenic data, neggasting that bages is
trusported through on enaschle of create with
the area of i by i in, each pair of crabs with
the area of it by it no, each pair of crabs conetituting an individual dife segment which opens
in differe applied by the limit research; 10° dyne
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10° dyne. The total moment integrated over the
writes denotes of traces to search proces.

10° dyne on the researce of these transport and

and Siructure of the studi and upper meaning GREAT YAN THE SUBDUCTING LITHOSPHEPS UNDER ALTERS TRUCKUR I SLAND AND MESTERS ORSIANY FAS ILLESTISSIC P WAYY COMPERSIONS.

ALTERS TRUCKUR I SLAND AND MESTERS ORSIANY FAS ILLESTISSIC P WAYY COMPERSIONS.

ALTERS TRUCKUR I SLAND AND MESTERS ORSIANY FAS 16802; long-period colerated of V waves recorded by the Citicaria, affiliah Columbiat and COR MCOVAILIS, wagest show general court large Pa curversions and later Articing P-to-S reverbarations not observed item typical commanded crument succione or from residently proposed attructures for these attailmus determined from ref arction surveys. The Islands and lerge applied of the Pa phone, relative to Mrate P, suggests in high velocity—contrast interface at 41 to 50 km depth under Vic and 108 forming the base of a distinct low velocity zone. This interface is proposed to be the oceant Nobe Mich is being bedueted under North America. forming the base of a distinct low voincity gone. This invalue is proposed to be the oceanic below with is heig technical under North America. Of a flood Personal of the Continuous off a flood Personal of the State of the Continuous off a flood Personal of the Interface. Personal of the Interface of Inter teophys. Red., Red., Paper 8081 683

Ciro Structure of the great and upper mantis INSA-MANE VELOCITIES AND CLOSTAL STRUCTURE OF THE LASTRE SHARE RIVER PLAIM, LOASO & Granafalder (Department of Geophysics, Medical Intersity, CA) and R. Kowsch The lithesphoric valuelly assuctors beneath the austern Saske Siver Plaim (SERP) is inforced from falso. in lithospheric valuelty arracture beneath the metter insite siver Filmin (ESEF) is inferred from filse on Bryloigh wave dispersion (periods 6 a to 48 t) and colsesimate shoet-wave delays, at being an other date from refraction profiling, text flow, volcenthe history, and geology. The charact velocity structure indicates a 12-km thick blab-moderity layer (depth 8 to 20 km), with F- and 8- velocition of 6,34 and 3.69 km/s, simperiory, with F- and 8- velocition of 6,42 and 1.1 km/s properticely. P- velocities as 4,82 and 1.1 km/s properticely. P- velocities and layer thicknesses are based no over interpresention of refreshed to the first structure of the first structure for the first structure for the first structure for the first structure for partine at 1. km/s. Specieshie S-velocities of Sparline at 1. km/s. the structure for the first structure for special structure f foring into the voluntions who that of the other of the voluntions who that or speed onto the fSEP between 10 and fa.y. 40. We twentying high-velocity large fa thought to compute acidic and begin thrustone of the Commonic size, and density into the other commonic size, and density with the best for exceed by thermal measurables riched to plutonics. (\$\frac{\psi}{2}\text{capper}\$ value (\$\psi\), and density in the first of the plutonics. (\$\frac{\psi}{2}\text{capper}\$ value (\$\psi\). Eachyla, Eat., Red., Paper 150298

upper bantle. The ise Pn valority in indicative of pertial satisfies in the upper mantle and implies that the crust is identical with the lithosphere. The bast fire date suggest that the lithosphere was about 48 km blef approximately 5 m.y. ago. On the basis of this, and a mantle of the country of the cou negative fres air gravity annually, we propose that the lithosphere has been thimsed from about 40 km to 24 km over thm pest 5 m.y. and will probably this sod upilit futther in the southern Benin and Renge in Artsona.

J. Geophym. Rem., Red., Paper 180373

6978 Strectute of the crust mod upper mantle A COMPARISON OF TER UPPER MANTLE STRECTORE SEREATH MORTH AMERICA AND SHOPE L. J. Burdich ILamont-Dobarty Geological Obser-vatory of Columbia University, Palisadas, New York 1096a)

valory of Columbia University, Pailsadas, Hes York 1926)
The tathuiques of modeling upper sentile sirutures by satching long paried waveforms with synthetic selsungers have been applied to observations from the tectonically steble pert of North America and froe Burdpe. The consistent dithrenates which can be reached by the long period data between Europe and Sorth America can be interpreted in terms of variations in the cost, iid end low valocity some. At apicentral ranges less shown 15°, the affects of shellow letters verisions are strong and body wave propagation is veglomaily dependent. Soveens ranges of 15° and 18°, ragional affects are still observed, but they can be explained in terms of ratistions about 18°, ragional affects are still observed, but they can be explained in terms of ratistions about 18°, wave propagation appears to be stable and independent of region. Host of the observed long period P waves propagation appears to be stable and independent of region. Host of the adjection of the rangel on the results of the saler distribution to the special parties of the saler distribution to the paper month before the this study with those of other studies indisases that the shape of the Pwelocity parties in fairly uniform through the transition ragion 1300-780 loss though there may be differentes in the shedute depth to the distoctinuities. These differences could, however, be the result of systematic errors in crewal time dails. (Systhetid selectorms, meetic structure, internal verlations.)

J. Coophys. Ros., Red. Pener 188f13

# **Tectonophysics**

8110 Convection currents
STEADY PROPAGATION OF MELANIMATION EVENTS
P. Bitd Conpertuent of Earth and Space Sciences,
UCLA, CA 9002a1 and J. Raumgardner
Deliasimation of the lithospheric thermal boundary from overlying continontal crust propagates
laterally from the line of initiation, acceleruting as the stabing slab of detached lithosphero
grows longer. This propagation has been numerically andsled with suculve-state equations in a
moving reference from by matching an inturior
finite-diamont volution to floating boundary conditions which represent the mechanical and therditions which represent the mechanical and ther-mai reapones of the surroundings. The form of the modulion depends on the shear coupling of inthe moistion depends on the annuar outping of a truding astherosphere to the top of the sinking mish across a thin later of crossal naterial. Without coupling, the tip of the introduction and siffices to form a wedge dividing the crust foold codes. With coupling, the introduction is icold codes. Mith coupling, the intruston is forced to convect and remains ductile that model. The cold mode can gropayate at all velocities; the last mode has a lover limiting valocity of 1-2 cm/year but offers less resistance at higher speeds. Resintance to deficientiation includes a constant term from the buoyant crustal downwarp, plus a velocity-preportional term representing viscous deformation. Nowaper, the proportionality constant of the latter term is only weakly dependent on crust and ilthosphere viscoulties. Hatching this resistance to localing ifnes of 100-800 km timbs sinhing in n countle of 107 p. velocities of 0.) to 8.0 cm/year ere obtained. Changes in viscoulty silect this rate, but cold-mode delamination is unstoppeble except at continental mergins or by latiure in the sinhing sleb. The surlate expression of delamination in a leading "outer rise" followed by a submarina trough with a large negative free-air enously, which (intelly workes into a lark pissanu. If crustal viscoulty and velocity ste both low, however, there is a bontonic crustal upfile with no rrough. Thus the present tech of linear supercontinental secana does not preclude delamination at up to 4 cm/yr drivan by slabs up to 480 km in length. docendent on grust and lithumphere viscoulties J. Geophys. Few., Sed, Papet 180016

8110 Convection currents
LABORATOPY CONVECTION EXPERIMENTS:EFFECT OF
LATERAL CODILING AND CREMATION OF ISLYABILITIES
IS THE MUSICONTAL BOUNDARY LATERS.
H.C. Notef (Laboratolre de Goophysique ac Geodynamique Interan, Sociesso 318, On twensice Paris-Sud.
91401 Orany, Yeantsi, C. froldavads, J.L. Lavrat and
M. Schlomy, Tentesi, C. froldavads, J.L. Lavrat and

Nablowicz
Conserion esperiments are carried out in a
cast wich two imothernal heat sintesth top pleas
and one of the sidewale. This steaming in eleclar to that of the iarth's subcomlinents; mostle
in the presence of a mighbouring subdecting
oceanic lithosphers. Oiffatential interferometry
and strictoropy ove used to observe the thernal
acructure of the converting fluid. The testal
cooling induces a large roil aith exis pevettel
to the cold wall. The warfaction of law width relacity to the raises of a fartical and a interal
Rayleigh numbers has been detarmined. As applicacion to the Earth's upper manrie would predict
roile (ive times ulder them high for largenough Rayleigh numbert, borndary layer images)
illing other time-dependant processes such as the
interlerometric melbod is very useful for visualixing other time-dependant processes such as the
growth of the indexed large roils. This growth is
repid orough to slow on to propose the existence repld mough the silow on to propose the existence of oweh large colis in the Earth end ergue that thair stitum could have led to complement break-up. (Corwection, subcontinents), expectments, sub-

duction) J. Geophys. Res., Red, Paper (20369

Bild Convection currents
HATLE CONVECTION WITS SPEELCH. EFFECTS
P. Olson (the Johns Hophins University, Beltimore,
P. Olson (the Johns Hophins University, Beltimore,
Haryland, 21218 (SA)
Reserve of a similarity rheady for apharical
manic convection are pissonted. The single-made
man field espectors sea analyted for convection
which is an vigorous that temperature discurbonwhich is an organization than thermal boundary
layers. Our purpose is to study alforms of
apharical geometry, density interlaces, base
source distribution and cail size. Steady stams
solutions are found for imprisons apharical
solution are found for imprisons apharical
solution are found for imprisons apharical
caicolations are carried out over the range
2 - 1 (40, and for verious Yeatless all interval
versus base heating. These casifactrions are
eximined? (1) convection in a single layer of
calls extending through the whole manife; (1)
convection in two layers, amperator, by a departing
in a single layer largeless and 10 give antipate
of surface as 670 he depth; and (10) to. Essential
in a single layer largeless and 10 give antipate
of surface her languard depth of circulation; the
interpat heating, and depth of circulation; the
interpat heating, and depth of circulation; the
surface velocity is made strongly elicated by
the known convection is a convecting spall. Deep manife
layer with observed plate spends, while convection can achieve but super, pastle does not. He
lesses of the aspic values of the signification of
the layton convection is one and into layer, to interthe layton produces a facil loyer spalls, while
the formar graphures.

ASIMPLY CONVECTION

AS MAPTLY CONVECTION

B.H. Nager [Select] onlice | Laboratory,
Colling and shick of Technology,
Panadens, fo Willi and M. J. O'Connell
freparations of Collegical Velecus, Varyard
University, Cathridge, Mass. 021381

Confing and shicking of lithospheric
plates with age and subdoction result in
large-scale borisonal density contrasts
tanding to drive plate actions and cantle
flow. We quantify the delium fotces
associated with these donaily contrasts to
deterative if they can drive the observed plate
rocions. Airst for rodnia are corputed to
evaluate the effects of assured rheologist and
boundary conditions. Us are unable to obtain
plate-live behavior in viscous codes with
traction-free boundary conditions. The
plates motion can be uposed as boundary
conditions and the dynamic consistency of the
moditie evaluated by detarolping if the net
force on each plain venicles the lithosphere has a Newtonian viscous choology,
the neil force on any plate is a strong
function of the affactive grid mpocing used,
loading to abbiguities in interpretation.
The otherwise viscous codel temoves these
sublight less. The nodel is estended to the
actual 5-0 impharital) plate geometry. The
observed velocities of rigid-plantic plain
are matched to the solution of the viscous
sublight less. The nodel is estended to the
actual 5-0 impharital) plate geometry. The
observed velocities of rigid-plantic plain
are matched to the solution of the viscous
stoke equation or the lithosphere
asthenousphare boundary.
Soly forces [ron the
differences in sirutture between continents
and oceans are fulluded. Interior donaity
contrasts such as those reculting from
upwellings from the thotom boundary fager
are assuand to occur on a seele scali competed
to plate diomators and are not included. The
driving forces [ron the density contrasts
within the plains are calculated and competed
to realisting forces trees the selection of contrasts
within the plains are calculated and competed
to realisting forces trees the selection of contrasts
wit to restating forces resulting from viscous and respectively to the conversion of the

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driving rechangent

8150 fiato sectorica DOIBLE SEISMIC 2001, BENESIM THE MARIANAS ISLANO Here R. Samoulli and Fordald V. Forsyth
(Copartment of Gadlogical Sciences, Stoom
Interestry, Providence, Pt. 02912)
A double zone of selectivity has been found
hereath the northern Marianan in the depth range
30 to 120 hz. The Sequidi zone undergone a pronounced bend, with radius of curvature whout 100
is, before straightening and descending nearly
vertically to a depth of over this 600 km. Thus,
the is an ideal who in additionable for
vidence of arreases associated with unbending of
the subducted oceanic piets. We relocated all
talessismic events from 1961 through 1975 using
t agional, competie restor-event rechnique,
which significantly decreded the ctatter of the
hypocenters. The three swents of the lower
selections are separamid from the upper time by
shout 10 to 35 km. The true thickness of the
upper seismic zone is probably 20 km or less.
The limited focal machanism deta indicates there
is doundly bession in the lower zone and do-mdip
repression in the upper rone. The selectivity
pattorns could be generated after by thermal
stresses or by subsyding a plate which was ortginally deformed annualitically. We show that
an alastic-perfactly piactic nuclei of the theology
of the plate associant for its separation of the
two estands sones, the focal machanisms, and the
steeler cetivity of the upper televate zone.
J. Geophys. Per., Red. Paper 180372 Hene R. Samuells and Postald W. Foreyth

8130 Plats retroates
VISCOSLASTE PUBLISHMENT TECTOTICS
3.R. Directon (Expt. of Capitalian Sciences, SUN',
Einghacron, N.T. 1390); and David P. Williams
The theory of methrane sackenics preposed b,
Yurcoize and Osburgh [1972] to explain intraplate
tensional fastures and satthquakes, and developed
by Turcoite [1974] for an abstle lithcopheric
membrane, is extended to the case of a viscoslesstic lithcopheric Each an extension may be espected to seriously modify the theory since, for
sid lithcopheric toother scrept the tery
bighost, the tion scale for viscoss relaxation te
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considered, the Exchange stresses generated by
though in plate survature do not encode '.85'
bers. Va conclude that sither the affective visccosity of the lithophore is much higher than
indicated by most studies, or membrane turbook
attenses play a erconform role in the generation
of intraplate laxitudes and withquakes, fintraplate extension, interplate sarthquakes, fintraplate (viscossity).
Gomphys. Res. iets., Paper 110009

Sizo Structume of the itchesphere.

PARRENT DRILLING IS THE WISTERS ATLANTIC OCEAN:
IL A SYMTHESIS & COMPANION PROCESSES AT
THE CERTACHOUS REDGE ATTS.
M. Y. J. Flower (Dept. of Goni. ici., Undu. of
Illinois, Chimpe, IL 50580) P. T. Rabbunco
Geobasical and geophysical stadies ol
bessitie sores whisioned from DDPs Sites offy and
AIS (W. Atlantic) show that (Creistous) druptless
orust are generated at a steble slow-primating
axis statiate to the present Hid-Atlantic Sites.
Interprelation of whole-ropk one green chamical
yestation in ampied lawas suggest thes megan
fracticustion of contrad in camporally and
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depth between the some of sagas segregation and
the ridge reset. It is suggested that make
spatially transless storage reservoits at various
depth between the some of sagas segregation and
the ridge reset. It is suggested that make
spatially granded of feontures. Eruptive
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are new verorded if 418A is 3M aslays).
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8170 Structure of the lithosphere
(RUSTAL CRUSSIS IN FOSLAND) CROPRYSICAL CONSTRAINTS ON CRUSTAL THICKENING WITH AGE
John F. Hinmance (Department of Goological
Sciences, Strum University, Providence, Pl 02912)
Cophysical reporticeols in sceland and adjacent overse suggest that crustal thicseling due
to underpissing provides a significant contribution to the tectools development of the legisland
Fisions and porhaps of the legisland-Fastor Pidge,
as well. The interpretation of recent aspectatoliuric and estants tolraction experiments
wegasts a todal in which tankfurderived talt
accumulates in a tilm layer fit's but at the besu wagasts a model in which martin-derived mels accumulates in a thin layer gT-5 km ti the besu of the crust hereath the securitaric tone. We suggest that, with time, this cett couls, soil-dillos, and accroters to the ham of the crust leading to coutes thickening. Solvaic experience indicate an increase in thickness of the icelandic trust from 8-10 km directly beneath the securitaria in a werge value at 20 km for the generatty older [148 my] colonel plateau. The much wider (celmod-Perco Midge has a crustal indicates at 18 my. Searcestics of material from chickness of 10 km. Suggestation of material from a significant volume of the mantie and the conclosed development of the crost, pricarily doc to underplating, any period wolf beyond the topolaries of surface goalfornations of solution neath regions as old as 10 to at the outface.
These results are compatible with a steple risk I ol luonentt, uplifr.

peoples. Res. telli., Proce 100100

8199 Gamarat of Wisconflameous OPEP ELECTRICAL SERVETURE OF THE CHIORADU PLAIRAU AS DEFENTRING PARK HARMETOTPLENDIC MEASUMMEMENTS 1. Pedaggon finion uti Empany, P. O. Bez 16. a. regardon enjoy of the sample, v. 6. 602 76, drea, CA 914[] 1. F. Heroinco Hagnototolluric mensurements on the Colorado Hagnototolluric mensurements on the Colorado Paratngton, New Modice characteristic the province as constating of Conductive Burtithe province as constating of consistive surficial solitons underlain by a more resistive crystalitie crust from the above 28 libeatern described the tendent of the libeatern described the tendent libeatern described the libeatern libeatern described a crustal the libeatern described a crustal libeatern described a crustal libeatern described a crustalitie libeatern described for the libeatern described as the libeatern libeatern described and the libeatern described and libeatern all-weakle realizately variations the either the range of 1109-1700 C at 10 km depth and yield a geothermal gradient in the major mantic of 1-4°C/km or less.

J. Geophys. Pes., Fed. Paper MORILIO

BIPS teneral or miscellanows SEISMOTECTORIES OF host-fielders United Stirs and ADJACENT CAMADA.

1. Tang (Lamont Schedung Geological Chartestory and Department of Collegest Schedung, 1975.

Phiversity, Validades, New York 1986. Y. Aggarwal

Data for local earthquakes recorded by a network of stations in northeastern United States and adjacent Camada were analyzed to study the seinmicity, the relationship between earthquakes and known faults, the state of stream, and crustal and upper manife valueity structure. In addition, portable seamographs were deployed in the field to study aftershocks. As a result, accurate locations for about 180 local marthquakes 17 m. 5 % and 25 focal mechanism solutions were determined. A Comparison of the spatial distribution of these spatial distributions the state of the spatial distribution of these spatial distributions the state of the spatial distribution of these spatial distributions the spatial distribution of these spatial distributions that the spatial distributions are spatial distributions and the spatial distribution of these spatial distributions are spatial distributions and the spatial distributions are spatial distributions and the spatial distributions are spatial distributions. etrinquates (1334-1919) revent that seimic activity in the morthwest is relatively stationary in space: those areas that have had little or moved the seimicity historically are telestwelly assistic today, whereas the historically active areas are also active toley. The instrumental locations, biscorical seismicity, and focal methods and solutions show an internal consistenty that help

solutions show an integraal consistency that help us distinguish two distinct selmogenic provinces.

The Adirondett - Western Quabec Provinces or northwesterly irealing some of selawic activity, about 200 km wide and at least 100 km iong, attending from the SE adirondects futo anothern Quabec, Cacada. Thrust Itulting on planes stribing SEM to NV appears to predominate and the incerted axis of maxless hortzontal compretation is largely uniform and trends MSV, nearly persiled to the talcalated absolute plate motion of North America. Little or no selemicity is found where anothers sourcope at the surface. Correlations between gravity anomalies and earthquish futations aggest that talcalate states for Sugravity anomalies and earthquish futations aggest that talcalies and earthquish futations aggest that talcalies and earthquish some vorbers. The Appalachian Province: A nottheastlarly trending some of asismic activity estending Prom southern Virginis to they Stonewich, Caneda. High-angle eaverse or throst faulting on the ME twending planes appears to pradominate. Yes vestor margin of this provious, however, appears to be relatively sentance of fanous activity youlded the totactivity to not un use of the following: 1) the appears of fanous activity youlded to the twenty faulting on the following: 1) the presence of fanous activity to actualing the Aredian orogen which may have annoaled on the faither faults. and if the readminate of during the Aredian progent which may have amposted pro-ratating faults, and )f the prodominents of durities an opposed to brittle deformation in the ductiin on opposed to hrftele deformation in the grotogic pass. The inletted sate of maximum hotisconel compression along the sactace sargio of the Appaiachtent is rather willors and trends 1.4WW. I closely perpendicular to the augments illnestions offshore. We segment that this W-MW compression estimate the gravitational fovos arising face horisonist decelly variations in the occase (Isbackharp as It cools and more away from spranding Ambates. Explorators, baggitude, lural mechanism molution, masfaum principal J. Gmophasi Res., Sed., Paper 180080

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itifium 8. Savage 19.8. Geological Survey, box 
13400, 1.8. 181, Beaver, Colorado 402201 
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contr Antertat to of the infen from a weelerly direction. High-pentage as the fine showed that the most recent for are being folded at the shoreward elde.